Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

SEPTEMBER, 1952

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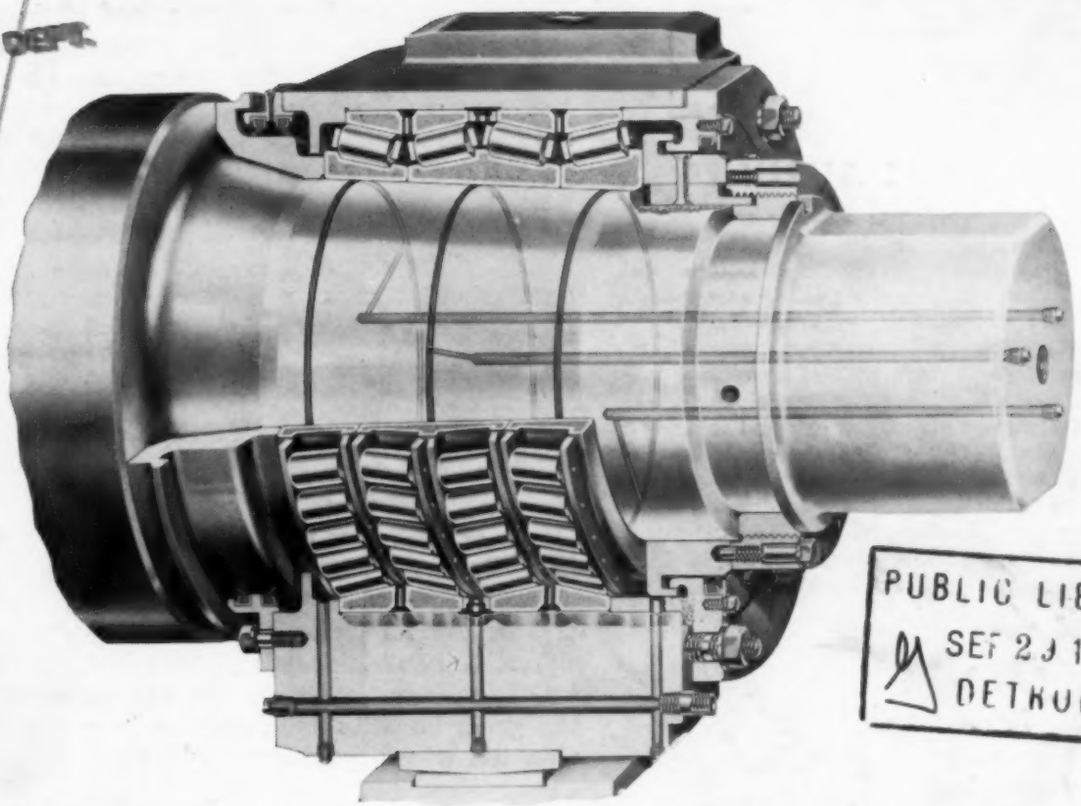
TECHNOLOGY DEPT.



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DETROIT

New tapered bore 4-row TIMKEN® bearing combines interference fit with easy removal!

NOW high-speed mills can get a 4-row tapered roller bearing that combines maximum bearing capacity and interference fit with easy removal! It's the new Timken® tapered bore bearing—long used in 2-row bearings, but now introduced in 4-row bearings for the first time.

The new Timken 4-row bearing with tapered bore is the greatest development in roll neck bearings since the Timken Company pioneered the first balanced proportion bearing in 1941.

Like other Timken roll neck bearings, this new tapered bore bearing permits maximum roll neck size and greater mill rigidity, eliminates need for special thrust bearings, makes possible higher rolling mill speeds, permits stopping and starting of mills without loss of steel.

For additional information, write The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

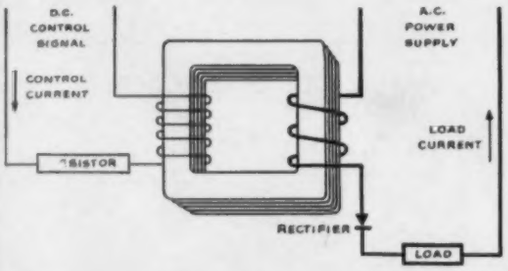
SEE THE APPLICATION OF THIS NEW BEARING DEMONSTRATED IN BOOTH 104-7 AT THE IRON AND STEEL SHOW

The application of this new bearing will be demonstrated for the first time on an actual mill roll. Roll necks will be gaged to within .0001" using the air gage principle as pioneered and developed by the Timken Company.

TIMKEN
TRADE-MARK REG. U.S. PAT. OFF.
TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ↓ AND THRUST →○← LOADS OR ANY COMBINATION

THE APPLICATION OF MAGNETIC AMPLIFIERS TO STEEL MILL CONTROL CIRCUITS



THE MAGNETIC AMPLIFIER

The magnetic amplifier as a motor control component has taken the electrical world by storm. Here is a unit that is simple in construction, that has no moving parts to wear out or get out of order . . . yet when properly designed and constructed and when properly engineered into a control scheme is capable of some of the most amazing control functions. Its response is swift, measured in a fraction of a second. It is accurate. It is immune to vibration and shock. Because of numerous installations Cutler-Hammer engineers have the knowledge and experience to properly apply the magnetic amplifier to control circuits of every kind.

Cutler-Hammer's practical knowledge of this newly useful component assures correct and efficient solution of your control problems.

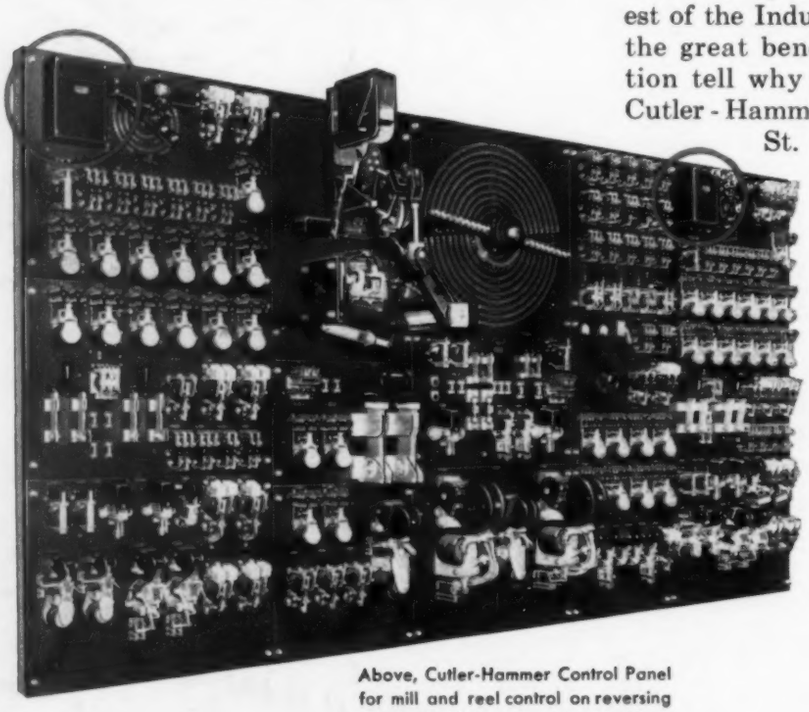
With a background experience gained by more than 50 years' intimate contact with the control problems of the Steel Industry, Cutler-Hammer engineers now bring to the Industry the knowledge and practical benefits of recent developments of the magnetic amplifier. The simple electrical and mechanical construction, the absence of moving parts, the tremendous versatility, the immunity to shocks and vibration, and the dependability of the magnetic amplifier recommend it to any steel mill man seeking higher production, better performance and more uniform operation in a wide variety of mill applications. If you have a problem involving:

Tension control	Acceleration
Voltage regulation	Positioning
Speed control	or any combination of these,

bring it to Cutler-Hammer.

The adaptability which the magnetic amplifier has in its performance characteristics and the need for skilled engineering experience of the subject are factors that suggest its application by men *competent* to do so.

Versatility and dependability explain the great interest of the Industry in this new method of control; and the great benefits derived from its proper application tell why experienced mill men are coming to Cutler-Hammer. CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wisconsin.
Associate: Canadian Cutler-Hammer, Ltd., Toronto, Ontario.



Above, Cutler-Hammer Control Panel for mill and reel control on reversing strip mill, utilizing magnetic amplifiers.

CUTLER-HAMMER
MOTOR CONTROL
C-H

See other typical Cutler-Hammer applications of magnetic amplifiers at Iron & Steel Exposition
Booths 46-47-48 and 49.

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 29, No. 9.

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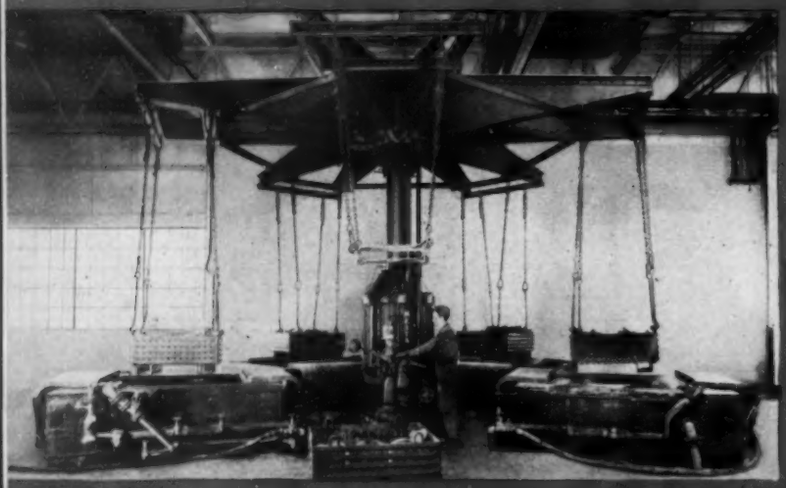
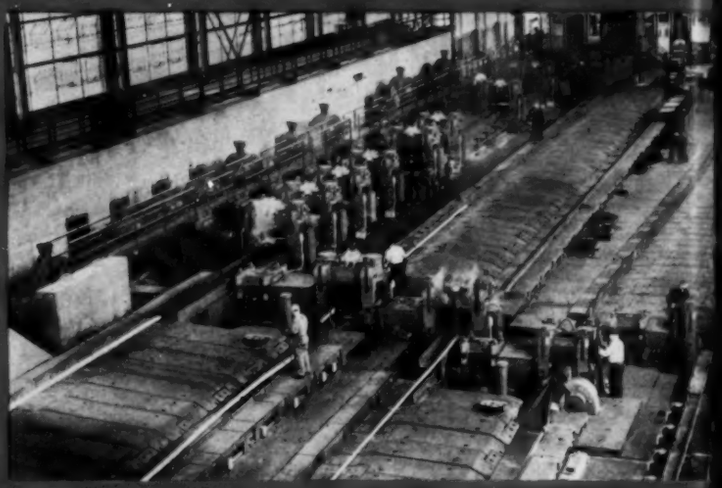
MESTA 56" FOUR-HIGH, FIVE-STAND TANDEM HIGH-SPEED COLD MILL

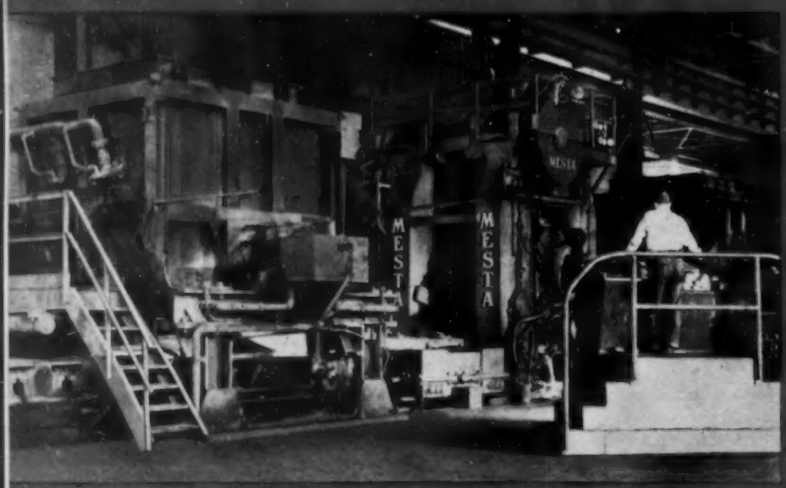
PAIR OF MESTA HOUSINGS FOR COLD ROLLING MILL LOADED FOR SHIPM



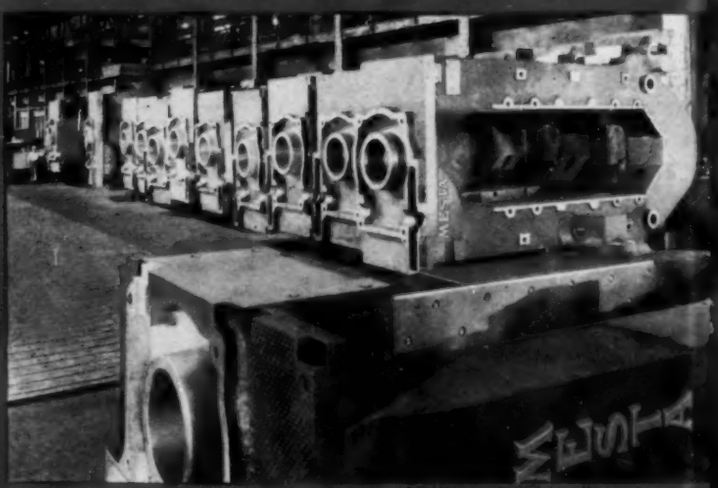
MESTA 32" PATENTED PICKLING MACHINE



MESTA MERCHANT MILL WITH PACK ANNEALING COOLING BED AND EQUIPME

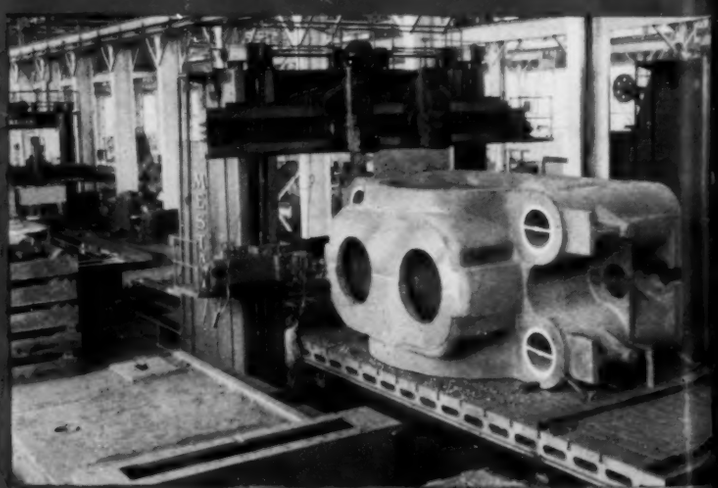


MESTA 42" FOUR-HIGH REVERSING HOT STRIP MILL



GROUP OF MESTA ROLLING MILL HOUSINGS ON ERECTING FLOOR

MASSIVE GENERATOR ROTOR SHAFT FORGED FROM INGOT POURED IN THE MESTA OPEN HEARTH DEPARTMENT



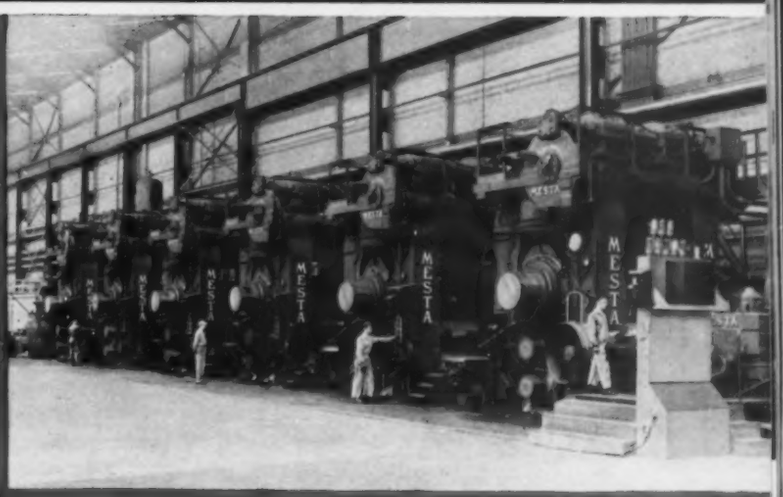
MACHINING CAST STEEL CAP FOR LARGE HYDRAULIC PRESS ON A MESTA HEAVY DUTY PLANER

Designed and Built By

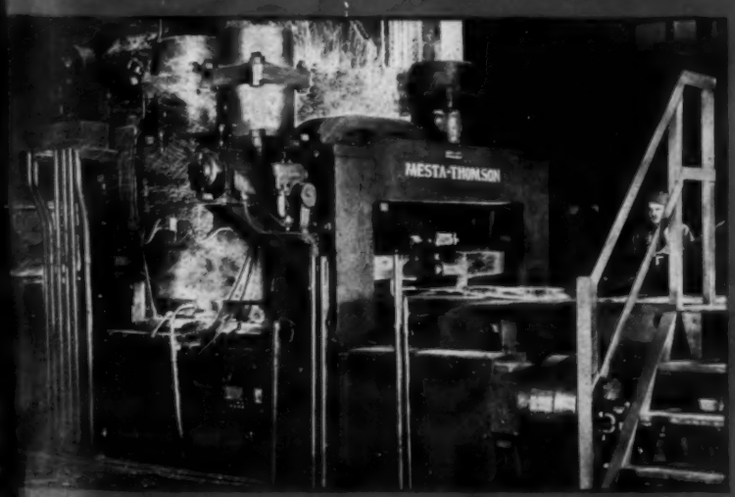
MESTA

MACHINE COMPANY
PITTSBURGH, PA.

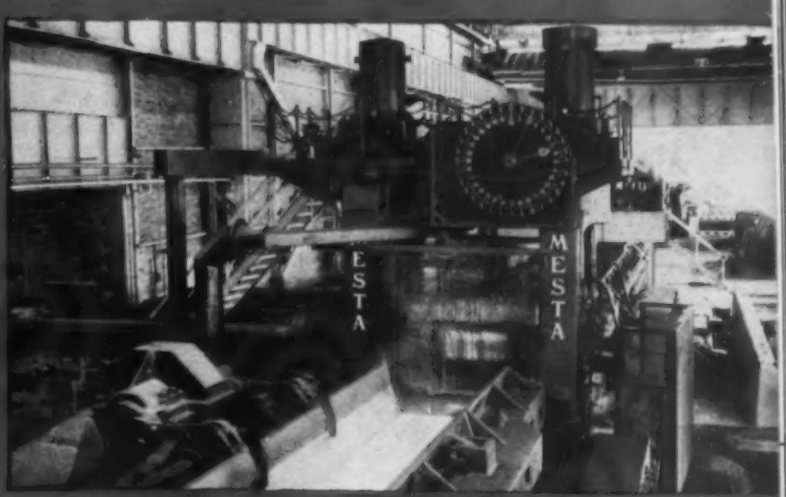
MESTA 18,000 TON HYDRAULIC DIE-FORGING PRESS



MESTA 68" FOUR-HIGH CONTINUOUS HOT STRIP MILL FINISHING STANDS

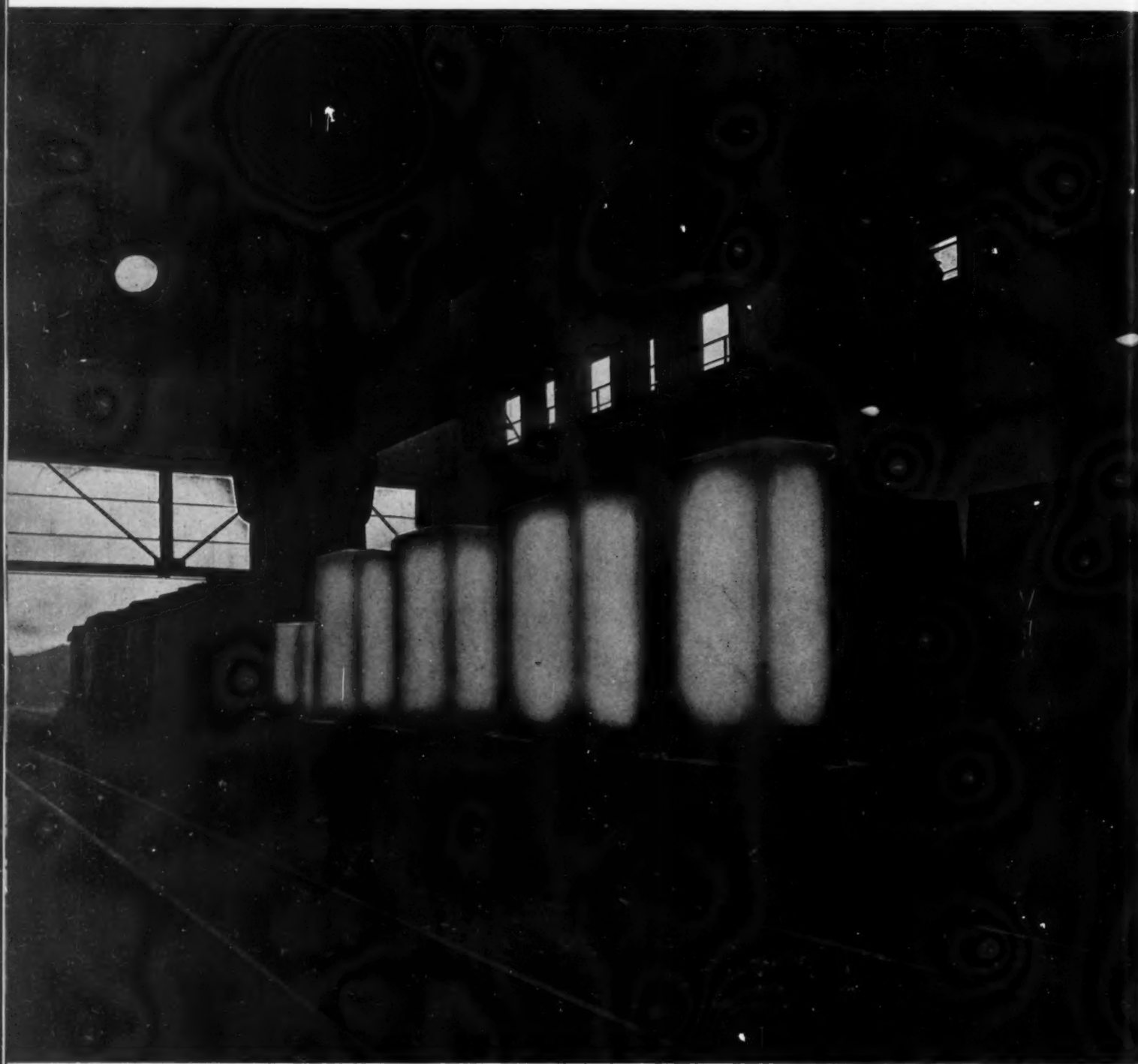


MESTA-THOMSON FLASH WELDER INSTALLED IN
A MESTA HIGH-SPEED CONTINUOUS PICKLING LINE



MESTA 46" TWO-HIGH REVERSING SLABBING-BLOOMING MILL
WITH MANIPULATORS AND TABLES

MOULDS **VALLEY** STOOLS



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You'll find that Gulf Sales and Staff Engineers do more than simply recommend the proper oils and greases for every type of equipment in your mill. They offer effective help on every phase of lubrication!

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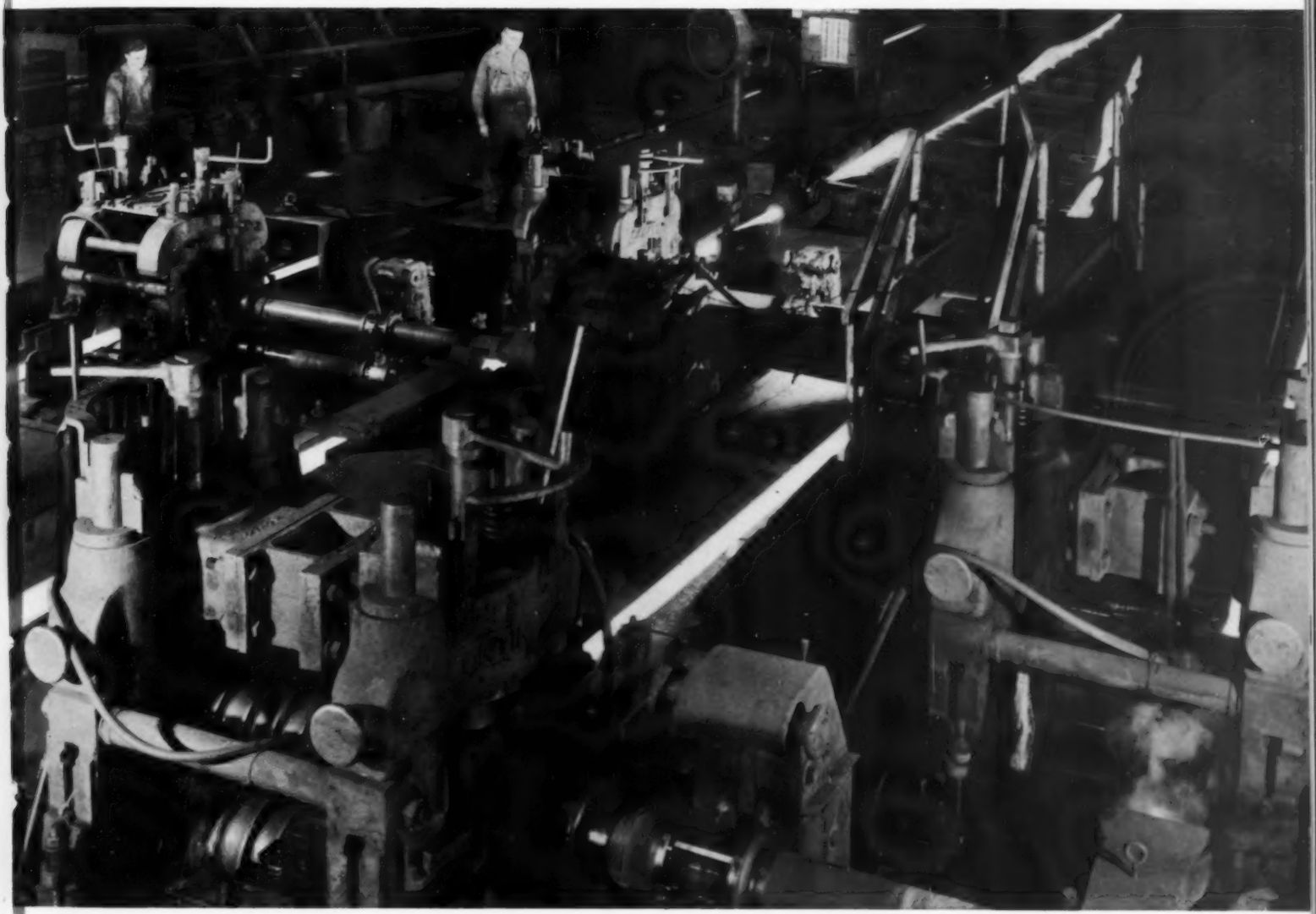

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Foundry & Machine
Company

Wagner
TRANSFORMERS
. . . the choice of leaders in industry

Wagner Unit Substation Transformers serve American Tobacco

One of the two double-ended unit substations equipped with 750 kva non-inflammable liquid filled Wagner transformers.

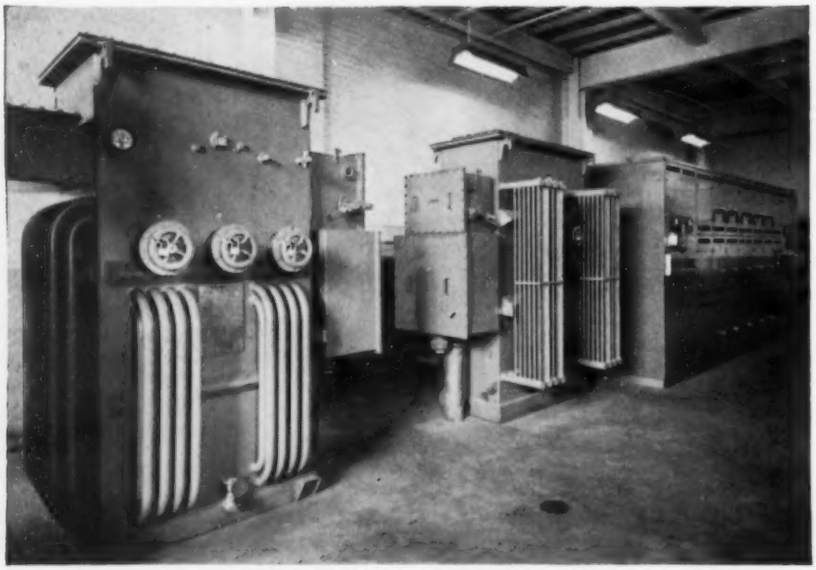
Two double-ended and two single-ended unit substations furnish power for all operations at Louisville plant...

Seven Wagner Unit Substation Transformers are used in the load-center power distribution system in the American Tobacco Company plant at Louisville, Kentucky.

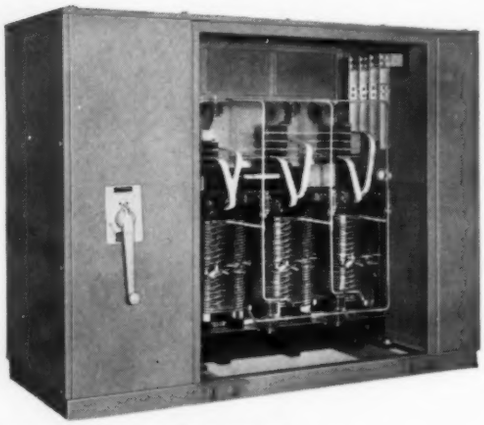
The system is formed of two identical installations—each consisting of a double-ended unit substation equipped with two Wagner 750 kva Noflamol transformers, and a single-ended unit substation with a Wagner 500 kva Noflamol transformer. Another 500 kva Wagner transformer is installed in the boiler room of the plant.

This installation furnishes power for lighting and for all operations, including the humidity control that is so important in the manufacture of cigarettes.

Wagner Unit Substation Transformers are carefully designed to meet your distribution requirements. Oil-filled and non-inflammable liquid filled (Noflamol) transformers are available with various types of entrances and controls for the high-voltage circuits, and with proper throats on the secondary side to connect to any make of switchgear.



One of the two single-ended unit substations in this plant. All transformers are 13800 to 240 volts, 3 phase, 60 cycle.



Dry-Type Indoor Transformers

Wagner three-phase dry-type load-center transformers are built in ratings through 2000 kva in the 15-kv class and below. Transformer and incoming line section are housed in compact factory-matched enclosures that are connected to matching secondary switchgear to form a closely coupled unit substation that affords ready accessibility. Bulletins TU-56 and TU-13 give full information. Write for your copies.

Wagner Electric Corporation
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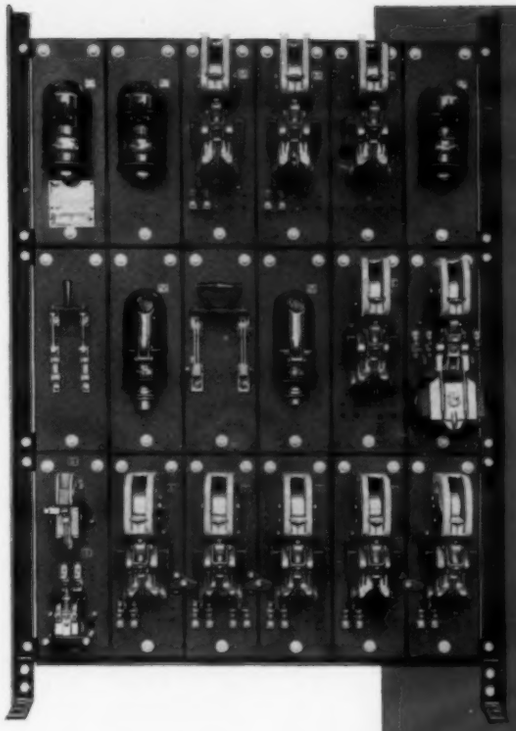


LOOK for these NAMES when buying Motor Control

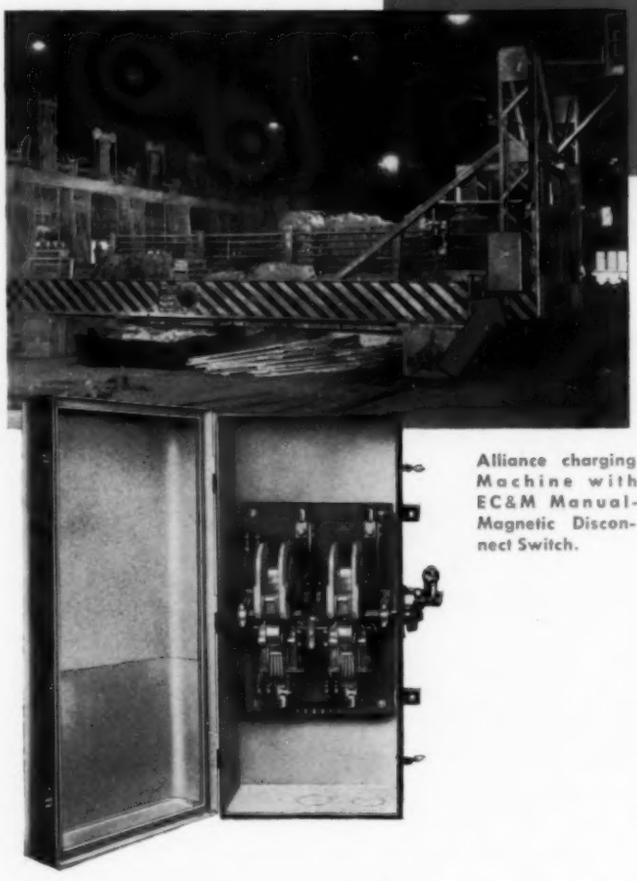
1 LINE-ARC Contactors
2 TIME-CURRENT Acceleration (D-c)
3 FREQUENCY RELAY Acceleration (A-c)
4 WRIGHT CIRCUIT Hoist Control (D-c)
5 YOUNGSTOWN Hoist Limit Steps
6 TYPE WB Brakes
7 CAM Master Switches
8 MANUAL-MAGNETIC Disconnect Switches
9 CONTRA-TORQUE Hoist Control (A-c)
10 TAB-WELD Resistors

These FUNCTIONAL NAMES Speak for Themselves

MANUAL-MAGNETIC
Disconnect Switches
for CRANES

*PUSH UP to Close
PULL DOWN to Open

Can be remotely operated from Cab Push Button when handle is UP.



Alliance charging Machine with EC&M Manual-Magnetic Disconnect Switch.

Meets crane specification for disconnect-means on footwalk and in crane cab. Only one unit to install—push button permits disconnecting the crane in an emergency from the cab.

High interrupting capacity—reduces spare-part problem because designed with crane control parts—built to withstand crane service—no delicate parts to loosen under vibration.

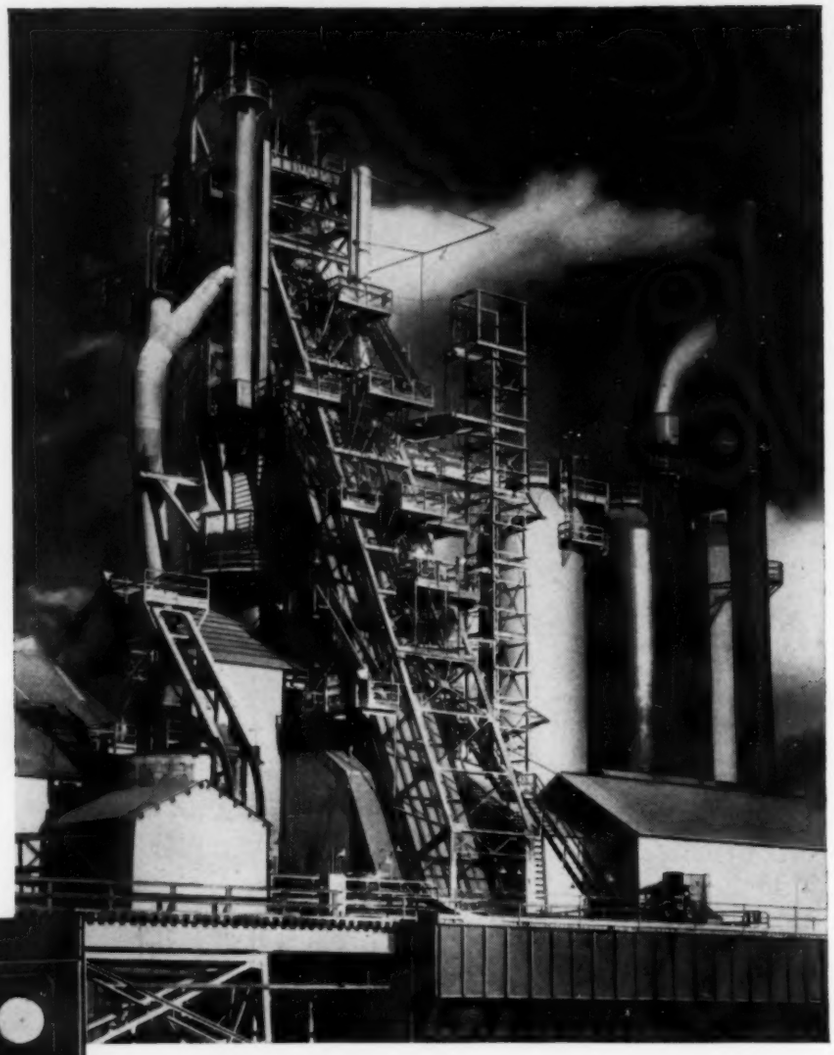
Easy to operate—magnetic operation simplifies positive closure to "full-on" position—pulling handle down opens holding circuit; manual follow-up by roller actuated by operating-handle shaft forces contacts open if contactors fail to drop-out—also prevents accidental closure.

Has auxiliary contacts for controlling signal lights—provision for padlocking in off position—front-connected leads—ample wiring space.

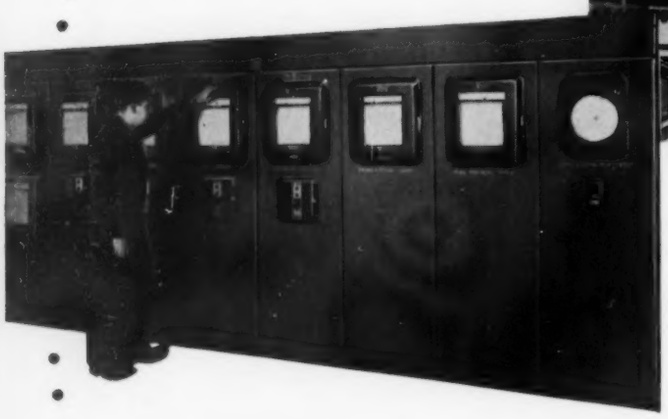
For Safety and Convenience, specify EC&M MANUAL-MAGNETIC Crane Disconnect Switches.

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO

• **SEE THE LATEST L&N** automatic controls for steel plants at Booths 99 and 100, the Iron & Steel Exposition, Cleveland, September 30 to October 3.



New 750 ton blast-furnace built by John Mohr Co. for Dominion Foundries & Steel Ltd., Hamilton, Ontario.



L&N OFFERS

more Cost-cutting instruments

THAN EVER BEFORE

• The complete furnace controls engineered by L&N now offer the steel industry more cost-cutting opportunities than ever before available. Some are outlined on the opposite page; they all stem from these basic facts:

1. More "variables" than ever before can now be controlled automatically. Fluctuations are headed off faster . . . more easily.
2. L&N instruments are designed specifically for steel-mill control . . . not just "adapted" to it.
3. In addition to being designed and built correctly, this equipment is *applied* correctly. Every installation benefits by the "know-how" accumulated during 40 years of work with the steel industry's production men, engineers, metallurgists and instrument technicians.

Correctly engineered and applied, L&N blast furnace controls are among the soundest, most advanced tools for making *more* iron . . . *better* iron.

If you're building or modernizing any type of industrial furnace, contact your nearest L&N representative, or 4942 Stenton Ave., Phila. 44, Pa., for information on automatic controls.

Don't miss "sequence" controls for blast furnace stoves

Because of great heat capacity, modern blast-furnace stoves are easier to operate when the usual one-drive-unit automatic control is replaced by L&N Sequence-Type Control utilizing two drive units. This control applies both to Stove Heating and to Blast Heating.

Stove Heating—With stove on gas, (See Fig. 2) Stove Burner Fuel-Air-Ratio Controller maintains fuel efficiency until dome reaches top temperature. Then Stove Dome Temperature Controller uses Drive Unit "A" to reset Ratio Controller, which puts in excess combustion air by operating Drive Unit "B", thus cooling the stove flame.

If stove dome temperature still rises, sequence action comes in and Drive Unit "B" passes control to "C", which throttles gas directly. Finally, when stove is fully heated, Stack Controller is last in sequence; it cuts gas back to preset level and holds stove at temperature until needed.

Principal advantages of sequence control to stove heating are:

1. High combustion efficiency.
2. Long stove life.
3. Warning of need for stove repair.

Blast Heating—Suppose Stove 1 is going on air. (See Fig 2) Its blast is too hot at start; Speedomax actuates Drive Unit "A" to open air-mixer valve and reduce temperature. Then, if the blast is still too hot, Drive Unit "B" picks up control sequence. It throttles undercut damper, forcing more air through the cold air mixing damper until temperature is right.

As stove cools, control action is then reversed; undercut damper is moved toward open, then mixer damper is moved toward closed, forcing more air through the stove and continuing until stove goes off air. Principal advantages:

1. Less "bump" of a hot stove.
2. Operator does not "nurse" stove.

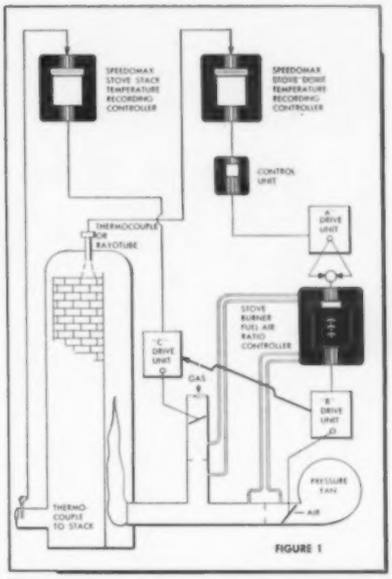


FIGURE 1

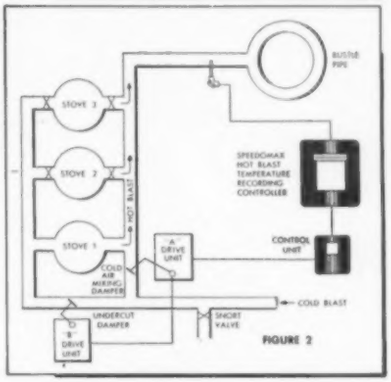


FIGURE 2

List of recorders for blast furnaces has recent and valuable additions

Speedomax Burden Recorder

Information about the motion of a blast furnace's burden is amply important, in the opinion of many superintendents, to justify the use of Speedomax Recorders as members of the team for helping the blast furnace produce more iron in less time.

Recorder fights "Dirty" Gas

Many a "dirty gas" complaint can be headed off, by using a Speedomax Dust Recorder. Regardless of cause of dirt, this instrument tells the gas plant promptly.

Speedomax Recorders for Top & Downcomer

A continuous record of top and downcomer temperatures enables operator to tell whether he should adjust blast pressure, change charging rate, or make some other correction.

Inwall Temperature Speedomax

This Speedomax Recorder helps prevent gas channeling and possible blow-through.

Recorder Saves Cooling Water

This Speedomax Recorder helps end over-cooling and resulting waste of water; warns of any overheating.

Quick Temperature Roundup With Indicator

A temperature "tour" of a hundred or more thermocouples can be taken in just a few minutes with a multiple-point Speedomax Indicator.

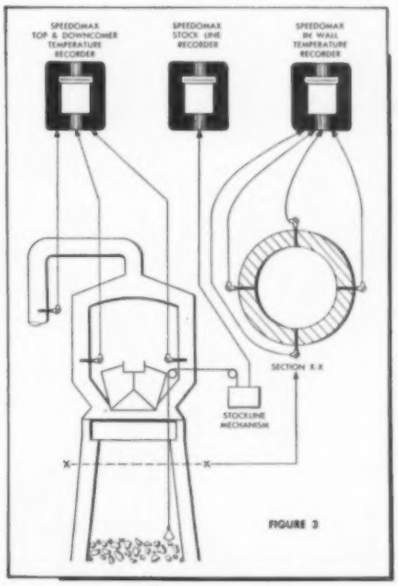


FIGURE 3

LEEDS & NORTHRUP CO.

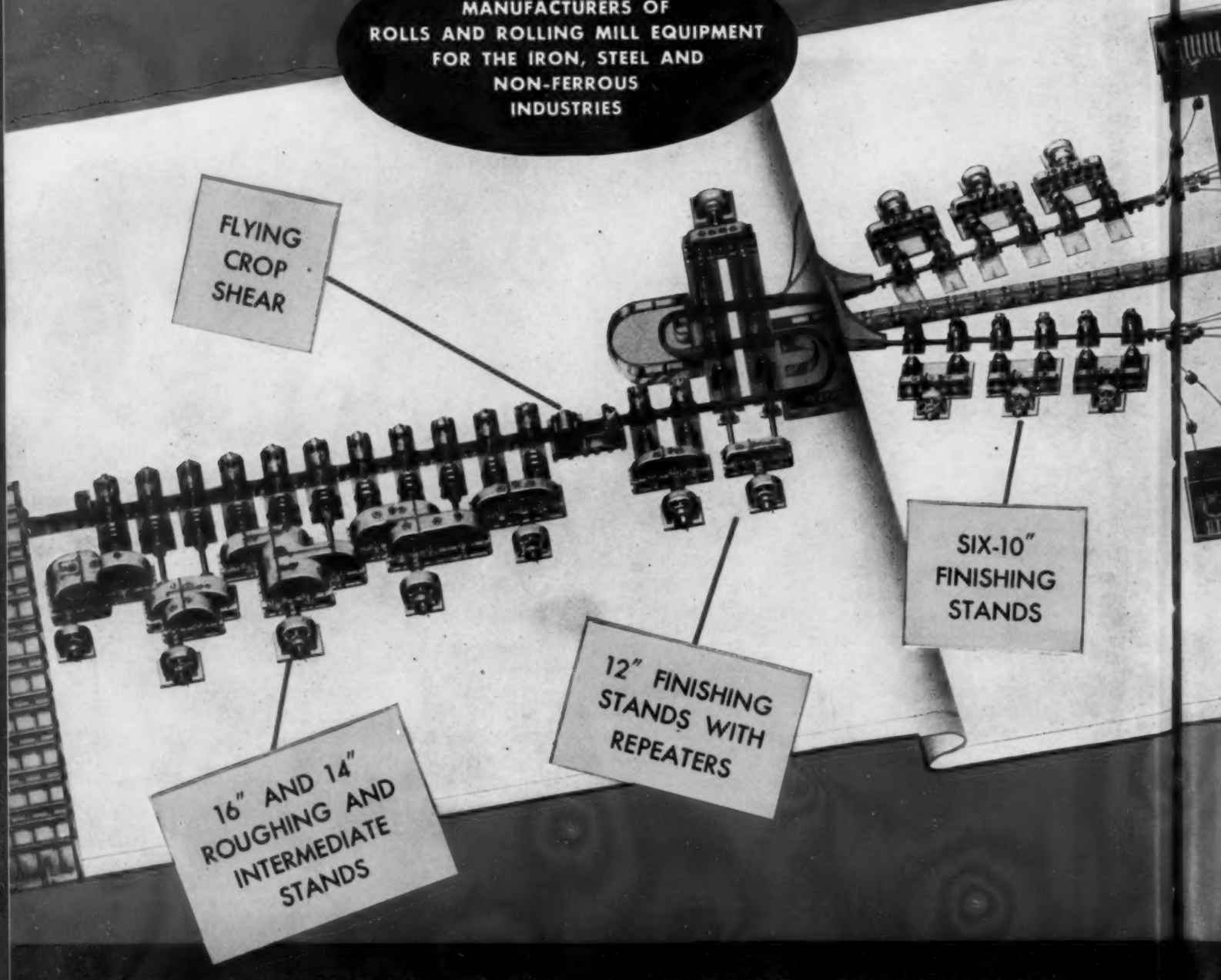
Career Opportunities at L&N—Expansion program of this long-established firm has many features to attract outstanding recent graduates in engineering and science. Opportunities are in sales field engineering, product and application engineering, research, advertising, market development. Widely-respected policies assure recognition of progress and achievement. Address Personnel Manager for preliminary interview at nearest of 17 L&N offices.

FLEXIBILITY
CLOSE TOLERANCE
TONNAGE

feature this Rod and Bar Mill by....

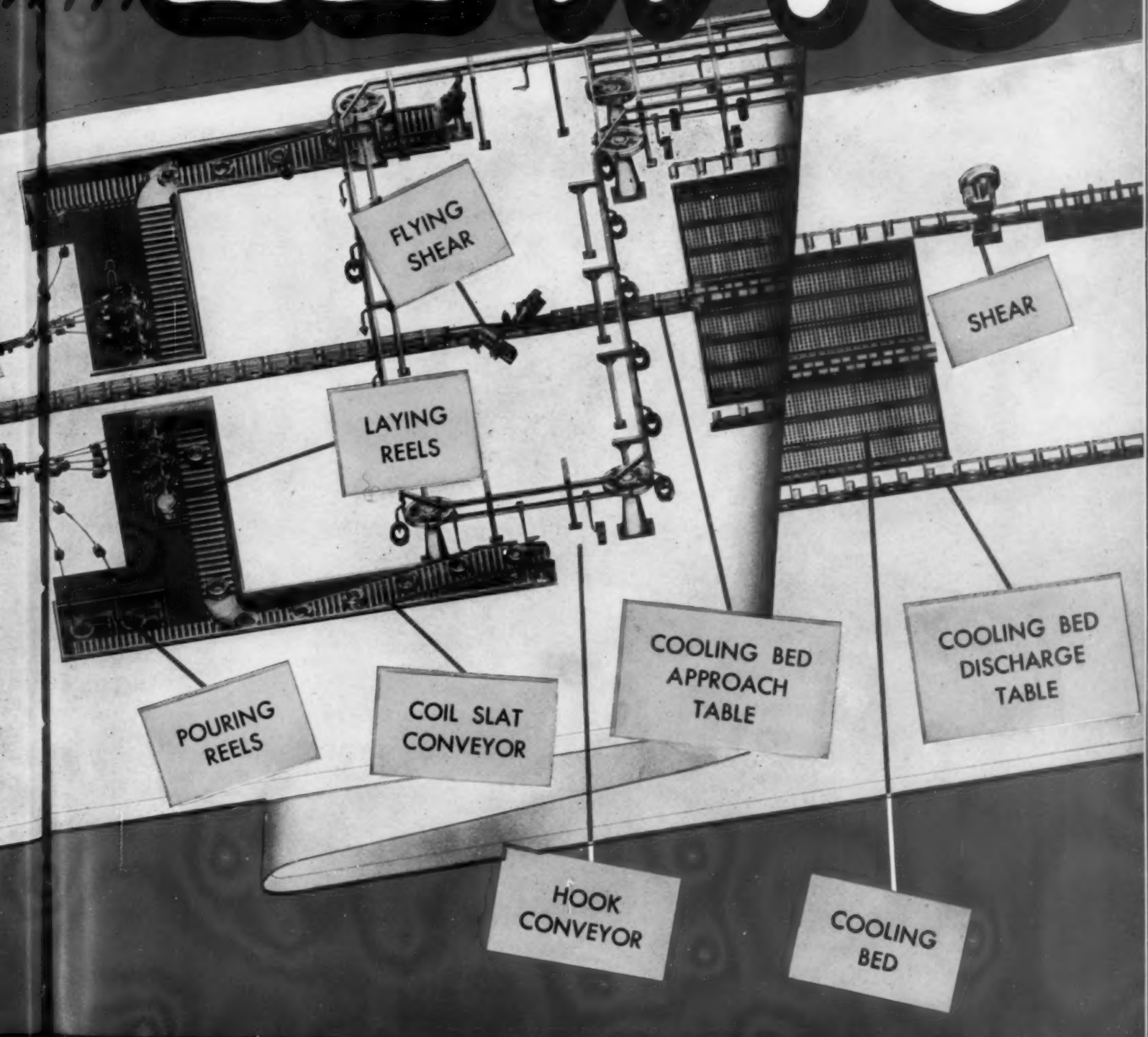
LEWIS

MANUFACTURERS OF
ROLLS AND ROLLING MILL EQUIPMENT
FOR THE IRON, STEEL AND
NON-FERROUS
INDUSTRIES


FLYING CROP SHEAR
SIX-10" FINISHING STANDS
12" FINISHING STANDS WITH REPEATERS
16" AND 14" ROUGHING AND INTERMEDIATE STANDS

LEWIS FOUNDRY AND MACHINE DIVISION OF

LEWIS

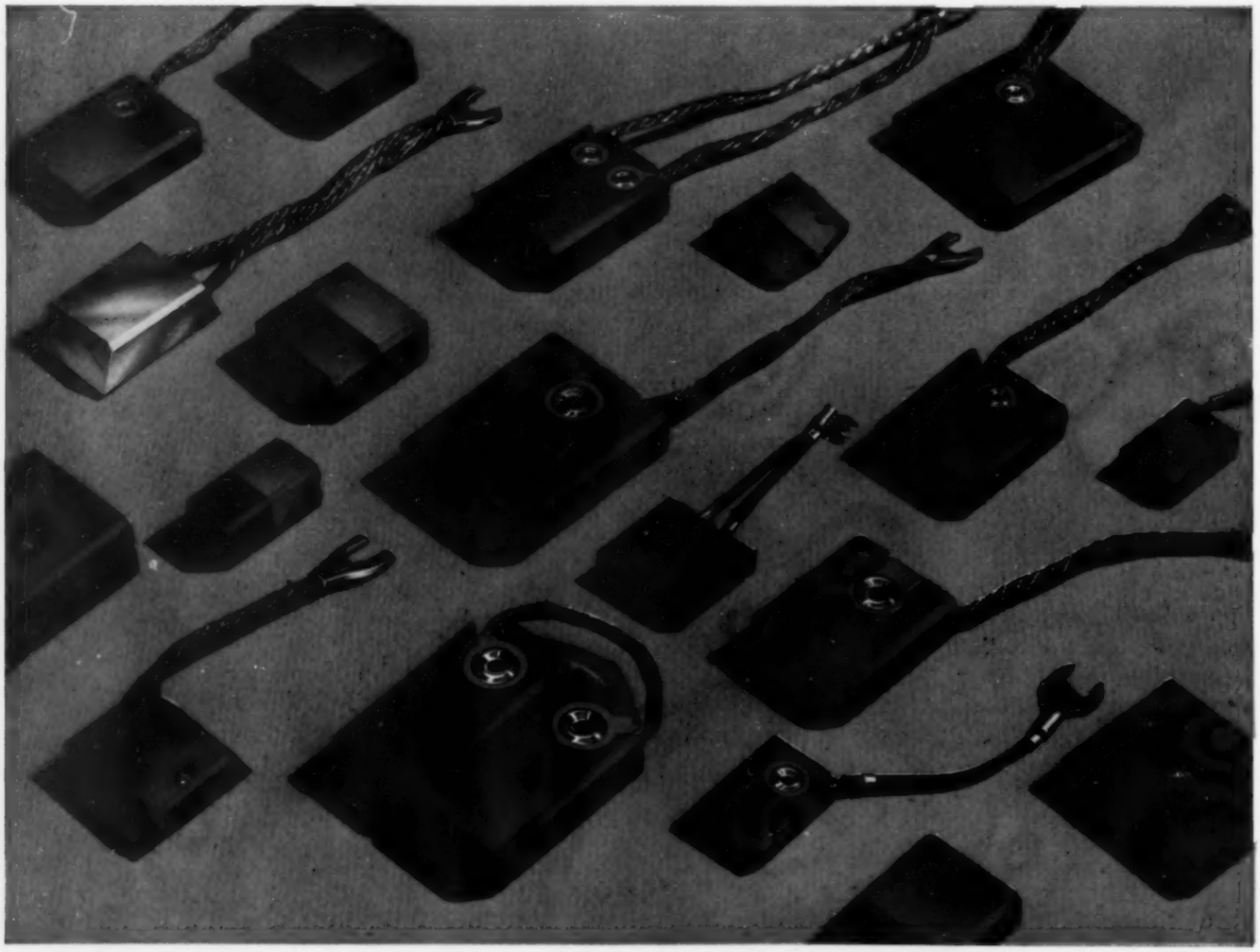


BLAW-KNOX COMPANY • PITTSBURGH, PENNA.

BUY USG BRUSHES

Try USG Brushes. They will solve those tough application problems for you. • Complete manufacturing facilities, plus continuous research and engineering make USG Brushes and Contacts the best you can use on all rotating electrical equipment. • USG BRUSHES can do a *better* job for you . . . Let us arrange a performance test to prove it.

Write today for 40-page catalog giving complete information on standard USG grades.



90-B

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

JOY ELECTRICAL CONNECTORS

are proving their value, by performance

BULLETIN B41

The most convincing sellers of JOY plugs and receptacles for Industrial applications are JOY plugs and receptacles themselves. Records prove that the initial installation in a Steel Mill, Scrap yard or Foundry invariably leads to widespread usage on many different types of mobile and stationary equipment.

Molded as one-piece Neoprene units, JOY connectors can't crack or smash out of shape when dropped — won't become mushy when smeared with grease or oil — and are absolutely moisture tight. Cork-like action of their water-seal also prevents metallic dust from accumulating around contacts.

Write for information on the complete line today. Let us show you how JOY plugs and receptacles can reduce your maintenance and replacement costs. Full details including a copy of Bulletin B41 (left) are available without obligation. Ask for them, now!

PLAN TO SEE THESE CONNECTORS AT THE IRON AND STEEL SHOW

Be sure to visit booths 58 and 59 in Cleveland's famous auditorium sometime during Sept. 30th through Oct. 3rd. Qualified personnel, in attendance during this entire period, will welcome the opportunity to shake hands, answer questions, and provide descriptive literature.

Consult a Joy Engineer

ME 752.1

JOY MANUFACTURING COMPANY

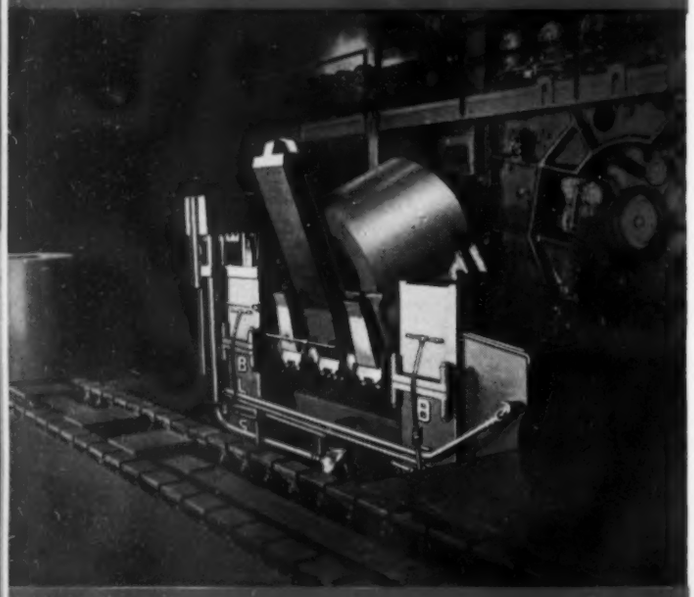
HENRY W. OLIVER BUILDING, PITTSBURGH 22, PENNSYLVANIA

IN CANADA: JOY MANUFACTURING COMPANY (CANADA) LTD., GALT, ONTARIO

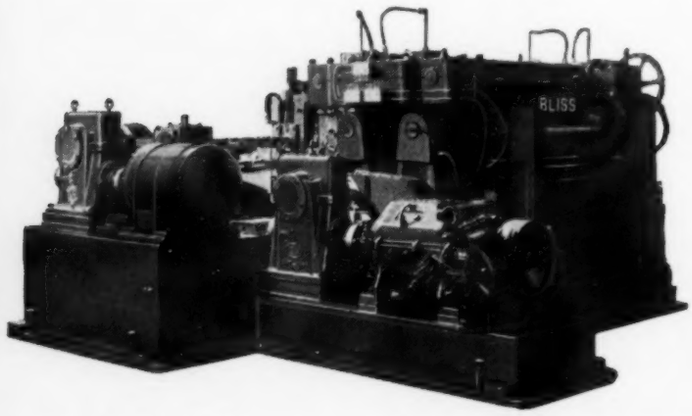
HOW BLISS DESIGNS FOR STEEL, BRASS

PRIMARY METAL PLANTS use hundreds of Bliss special-purpose machines in conjunction with hot and cold reduction mills. In every case, backed by field research with industry's engineers, Bliss has drawn upon its engineering skills to create equipment combining the necessary ruggedness and precision for the job at hand.

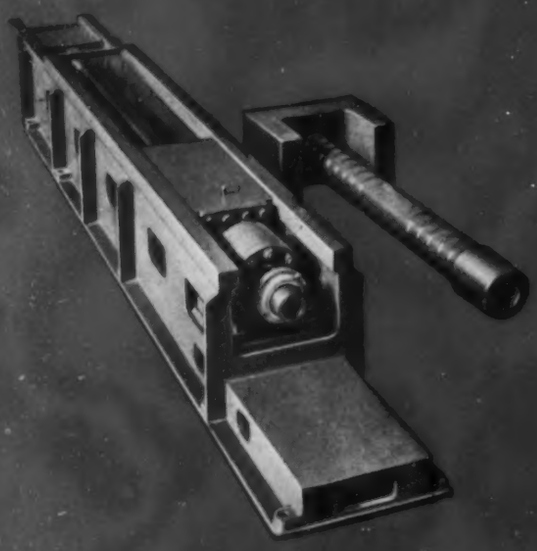
Pictured on these pages are typical exam-



COIL UPENDER strips hot 25,000-pound coils from the Mandrel Coiler, upends and deposits them on a "waffle top," which in turn deposits coils on the moving conveyor strands without damage to coil edges.



13 ROLL BREAKER produces scale-free and inclusion-free product which is suited for final reduction operations.



ROLL CHANGER WITH SLIDING RAIL permits easy roll removal from the mill and reduces required crane capacity. Balance bar is used to handle work roll assemblies including chocks and bearings.

RUN OUT DELIVERY TABLE specially designed by Bliss has slab sweep-off sections opposite piler. A slab pusher is provided on one side.

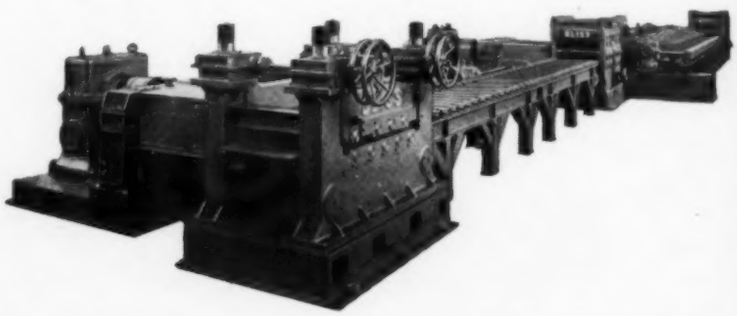
AUXILIARY EQUIPMENT AND ALUMINUM MILLS

ples of mill accessory equipment designed by Bliss. The complete range is described and illustrated in a new 52-page brochure soon to be published. You can reserve your copy now.

Next time you need auxiliary mill equipment, call in Bliss engineers.

E. W. BLISS COMPANY, General Office: Canton, Ohio
ROLLING MILL DIVISION: SALEM, OHIO
E. W. Bliss (England) Ltd., Derby, England
E. W. Bliss Company (Paris), St. Ouen sur Seine, France
PRESSES, ROLLING MILLS, SPECIAL MACHINERY

WIDE HORIZONTAL-TYPE BELT WRAPPER **is used in conjunction with Tension Reel to coil strip on the fly into tight, uniformly wound coils.**



COMBINATION LEVELER AND SLAB MILLER **levels the slab, mills one side, turns the bar over and mills the other side. It is used in brass and aluminum mills to prepare metal for final cold reduction.**

COIL LIFT AND TURN-AROUND UNIT transfers coils weighing up to 30,000 pounds from one leg of conveyor to another. It operates at either 90° or 180°. Perfect coil edges are retained.

TENSION REEL AND BELT WRAPPER handles 30,000-pound coils. Forced-circulation oil lubrication pump and piping are shown clearly on the typical Bliss gear reduction unit.

Modern Safeguards—Brink's for Money, Bailey for Process Materials

Are Your Process Materials Guarded As Well?

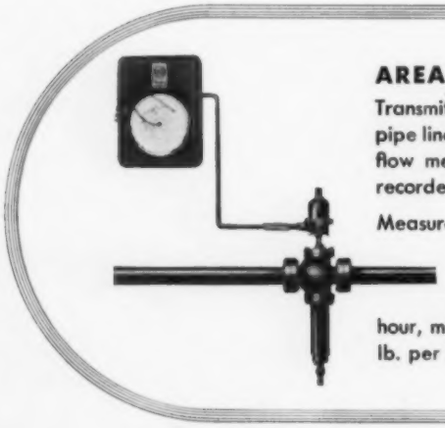
HERE'S HOW TO PREVENT SPOILAGE AND WASTE . . .

TO avoid waste of valuable process materials and finished products, process rates and conditions must be accurately measured and controlled. That's where Bailey Meters, Analyzers and Controllers can help you to improve the efficiency of your plant.

Take flow for instance. Bailey Meter Company offers a complete line of flow measuring and controlling equipment for applications ranging all the way from high pressure steam to low pressure gas. We measure flow in pipes, open channels, ducts, furnaces, smelters, kilns, ovens, dryers.

When you call Bailey Meter Company, you get the help of years of experience as well as recommendations from a wide selection of measuring and controlling devices.

Your local Bailey Engineer is as near as your telephone. He has the experience and the equipment necessary to set up an effective guard for your process materials. P-26



AREA TYPE FLOW METER

Transmitter goes into 1, 2 or 4 inch pipe line like a valve and transmits flow measurements electrically to recorder in remote location.

Measures oil and other clear liquids under static pressures up to 600 psi. Minimum range 0 to 1200 lb. per hour, maximum range 0 to 9600 lb. per hour.

BAILEY METERS

BAILEY METER COMPANY

1047 IVANHOE ROAD
CLEVELAND 10, OHIO

Process Controls

TEMPERATURE · FLOW
PRESSURE · LEVEL
GAS ANALYSIS · RATIO

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ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

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Designers and Builders of Ferrous and Nonferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other Heavy Machinery. Manufacturers of Iron, Nodular Iron and Steel Castings, and Weldments.

HIGH SPEED

CONTINUOUS

ANNEALING LINE

designed to save manpower and reduce upkeep costs

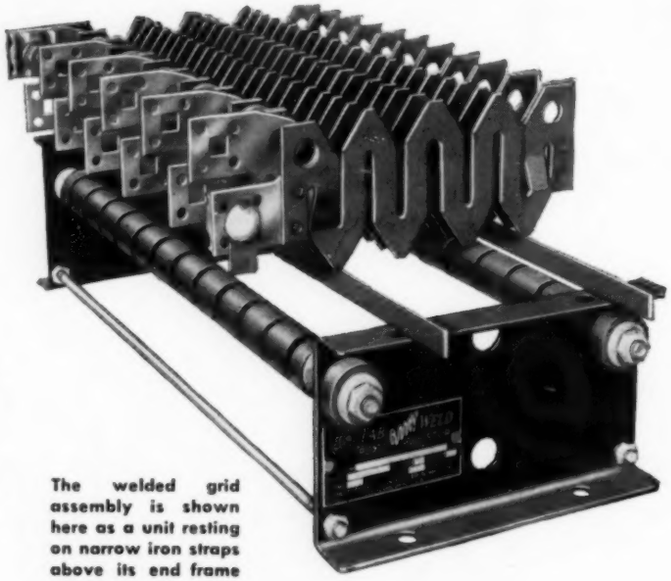
The welded GRID-ASSEMBLY steps up resistor-performance these 3 ways:

1- STABILIZES the ohmic value, independent of the clamping-nuts.

2-STOPS BURNING at grid-eyes and at tap-plates.

3- SIMPLIFIES tap-shifting, when adjusting resistance for best motor operation—also makes it easier to replace sections.

For reduced maintenance where maintenance can be easily overlooked, switch to EC&M Tab-Weld PLATE RESISTORS.



The welded grid assembly is shown here as a unit resting on narrow iron straps above its end frame support rods, and spacers.

SPECIFY BULLETIN **942** *EC&M TAB-WELD RESISTORS*

THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79TH STREET ★ CLEVELAND 4, OHIO

Joe Humenik began his career at Okonite in 1911. Today, his 40 years of skill are part of the vast know-how which goes into every cable. Here, he is applying a braided cover to a 60,000 volt shock-proof X-ray cable developed at Okonite.

• • •

Joe's son Ed, one of the many second generation employees at Okonite, joined the company in 1940, served 4 years in the Navy, now inspects and packages Okonite's famed Manson friction tape.

THAT ELUSIVE "Something"

Pride in a job well done is all too rare these days. Yet pride in workmanship puts something into a product that neither machine nor material can contribute.

That elusive "something" is an integral part of every Okonite cable. Added to Okonite's premium materials and advanced manufacturing techniques, it spreads the extra margin of quality that tips the balance between a cable that's superior and one that is merely good enough.

Meticulous care in the making of insulated cables contributes heavily to the performance of vital electrical circuits. It has helped to make Okonite cables the outstanding choice for reliability among leading utilities, railroads and heavy industries.

This craftsman's pride in his work is shared by countless Okonite employees. Better than one out of every six have worked here 20 years or more. Many are second, even third generation employees.

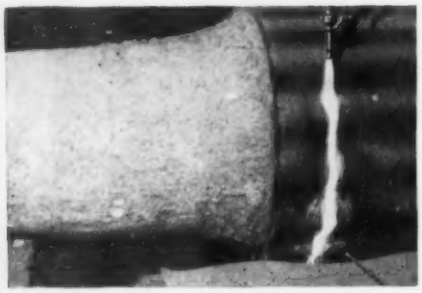
They're skilled workmen . . . proud of their jobs and proud of their company. The Okonite Company, Passaic, N. J.

THE BEST CABLE IS YOUR BEST POLICY

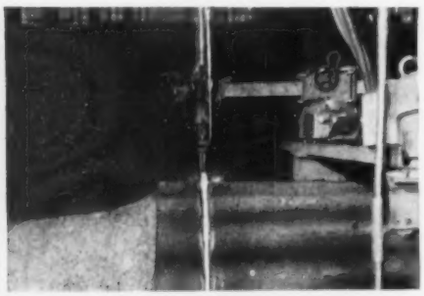
1540

insulated wires and cables

A 31-TON INGOT *SLICED* IN 35 MINUTES!

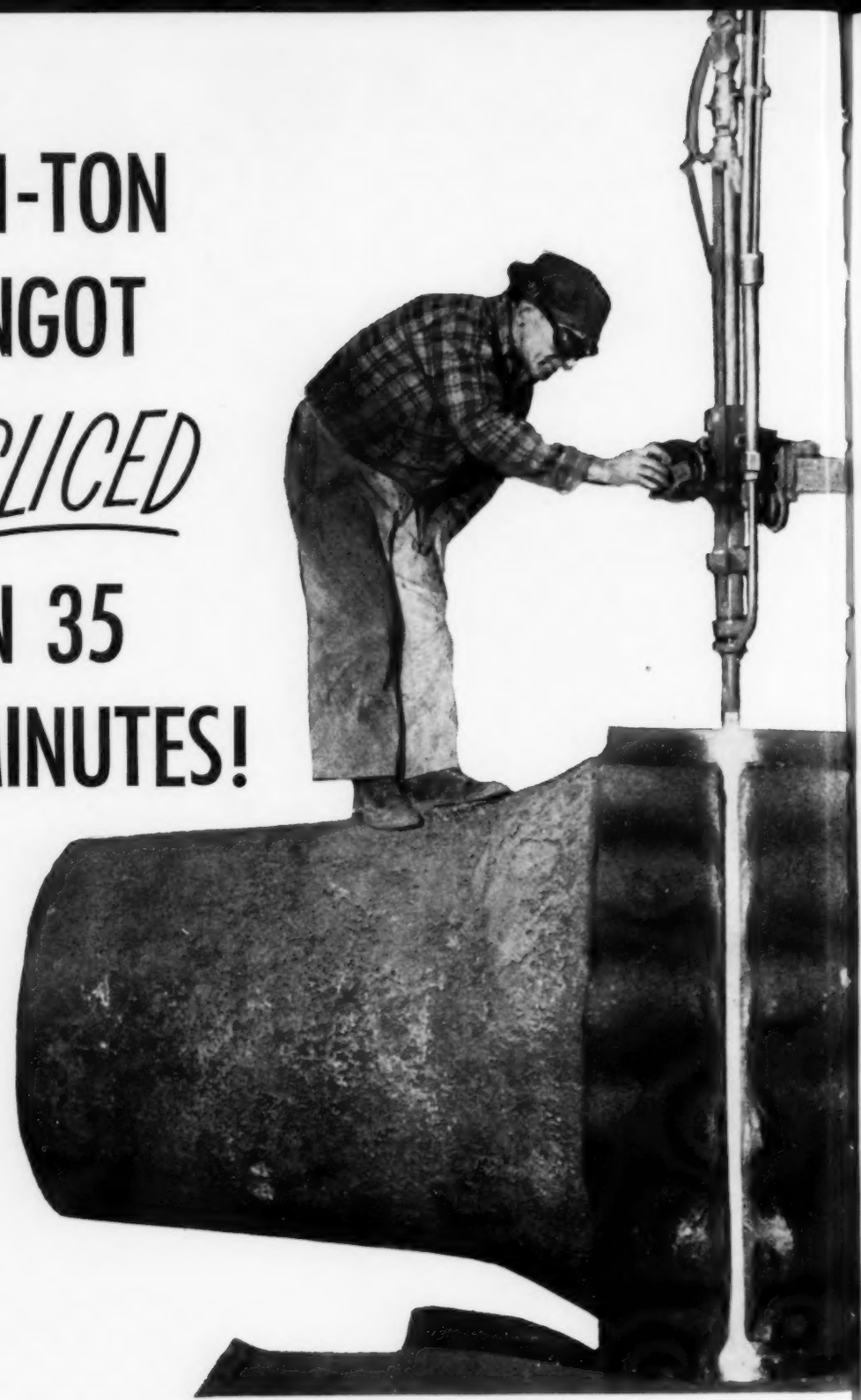


GOING... Cropping massive ingots to workable size is a routine operation at the Canton, Ohio plant of Industrial Forge & Steel, Inc. Shown here is a 62,500 pound corrugated steel ingot with an Airco No. 6850 heavy duty torch in position and starting the cut. Cut must be exact to produce a rough forging of specified weight.



GOING... This section was first heated to 600°F. After five minutes of torch preheating, the 6850 was put into action at a forward speed of approximately 1.5 inches per minute. Halfway through this huge section, the cut is clean and symmetrical . . . yet the operation is virtually unattended!

GONE! Note the smooth "face" on the severed ingot. This photo was taken 35 minutes later . . . and the ingot is now some 21,524 pounds lighter — "precision-cropped" to a weight tolerance. The Airco 6850 will do a similar job on sections that range from a foot in diameter — to a full six feet . . . and tips are available for acetylene and other fuel gases. For details contact the nearest Airco office!



Visit Airco Booths 138-140, Iron & Steel Institute Meeting, Cleveland, Ohio, Sept. 30—Oct. 3. See the 6850 torch and a "live" Aircomatic® demonstration.

AIRCO®

DEALERS AND OFFICES IN MANY PRINCIPAL CITIES

AIR REDUCTION

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AN AIR REDUCTION PRODUCT

at the frontiers of progress you'll find

FROM THE TOP STEEL PRODUCER . . .
TO A LEADING CHEMICAL HOUSE,
A YEAST COMPANY
AND A MEAT PACKER . . .

Heat Prover SERVES 62 DIFFERENT COMPANIES IN THE GREAT CHICAGO INDUSTRIAL AREA!

The Cities Service Heat Prover is graphically proving its worth to all kinds of industry in the Chicago area and elsewhere throughout the country.

62 different companies, producing everything from steel to beef, have found the Heat Prover an important aid to increased production and big dollar economy.

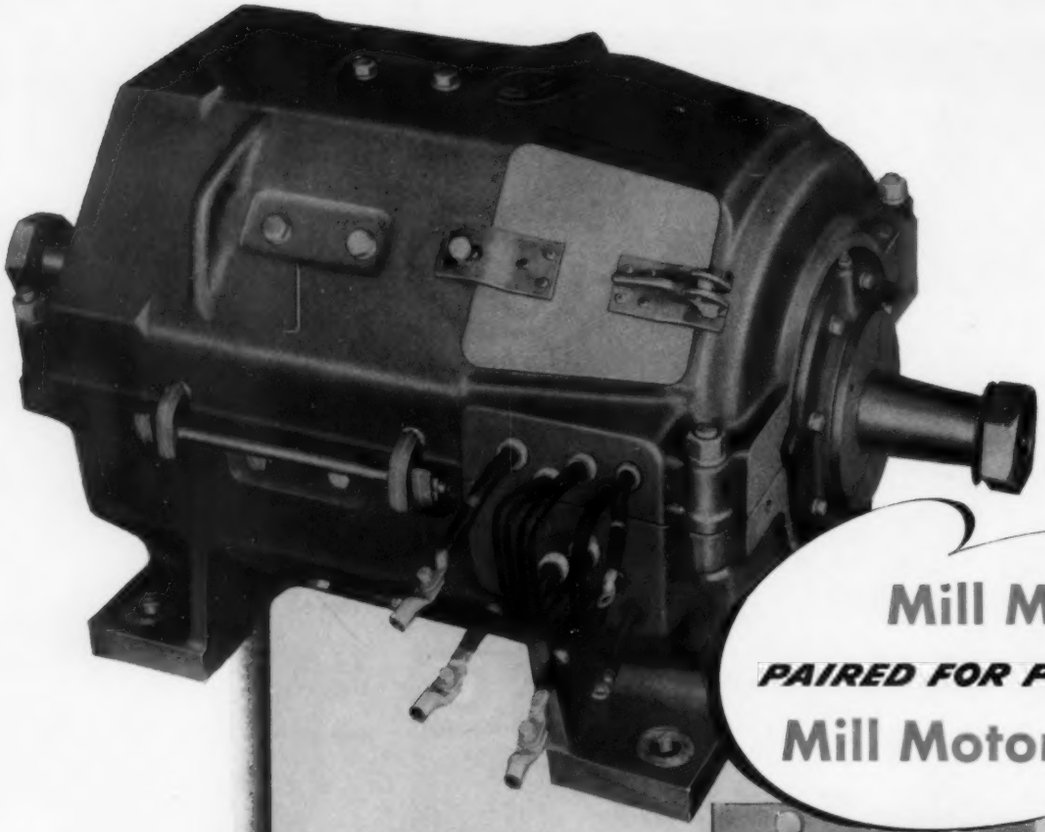
WHEREVER A FURNACE OPERATION IS INVOLVED, Heat Prover can help increase productivity by providing:

1. **Rapid, continuous sampling.**
2. **Simultaneous reading of oxygen and combustibles.**
3. **Direct measurement of oxygen and combustibles.**
4. **Easy portability.**
5. **No maintenance; no re-calibration.**

REMEMBER: Heat Prover is not an instrument you buy but a service we supply. Contact the Cities Service office in your area and learn how Heat Prover can serve you . . . or write CITIES SERVICE OIL COMPANY, Dept. I-17, Sixty Wall Tower, New York City 5.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

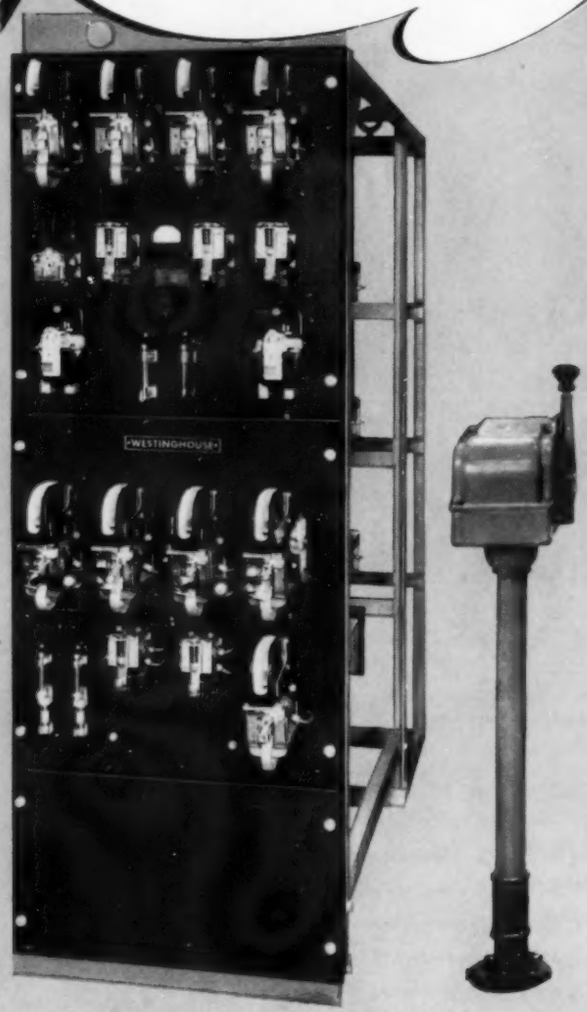


Mill Motor

PAIRED FOR PRODUCTION

Mill Motor Control

600 Series Mill Motor



Typical 9500
Line Controller, Type M
Contactors and Type SM
Master Switch

Rugged!

cut mill down time with this team

Certainly in a mill, where down time costs add up fast, the ability of equipment to stand up to rugged continuous duty is of paramount importance. That's why you'll find this combination hard to beat. They are rugged . . . made together to work together. Each incorporates the latest design features to keep production lines rolling.

Take the motor for example. The high starting torque of this new 600 series mill motor is ideal for high inertia loads . . . proved commutation . . . high rated efficiency assures maximum performance under tough service conditions . . . simplified construction makes servicing and maintenance easy. It is a brand-new motor with a new kind of performance built for today's tougher jobs.

Controllers, too, are built to assure new dependability. Main contactors are the new Type M with knife-edge, trouble-free bearings . . . with exclusive Quick-Quench arc boxes which greatly increase contact life. Overload relays are the dual thermal instantaneous type. Accelerating relays are the time-proved inductive time delay Type AZ.

The third part of this control team is the rugged Type SM master switch. Easy to operate, yet with a definite "feel" for each operating point of position, the switches are available with 2 to 6 speed control.

Together, these three offer a new kind of dependability. Get the facts on all three. Ask your nearby Westinghouse representative for a copy of the new booklet B-4730, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21647

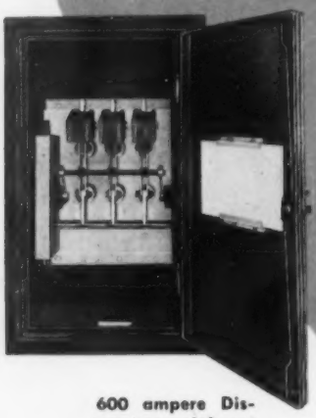
YOU CAN BE SURE.. IF IT'S

Westinghouse

MILL MOTORS AND CONTROLS

DESIGNED AND BUILT EXPRESSLY FOR THE STEEL INDUSTRY

DELTA-STAR'S NEW DIS-RUPTOR SWITCH



600 ampere Dis-ruptor without fuses . . . for interrupting service only.

These new heavy duty metal-enclosed switches are designed for 600 volt A.C. or D.C. service . . . combining the functions of both disconnect and load interrupter. Rugged in construction they are designed for severe usage in steel mills and other heavy industries.

Available in current ratings of 400, 600, 1200, 2000 and 3000 amperes, the Delta-Star Dis-ruptor is applicable for use in opening motor circuits; for main entrance or branch feeder control; as disconnects for transformers, capacitors, furnaces or ovens, and other similar applications.

With its arc-rupter chamber, the Dis-ruptor offers consistant, safe, positive load interruption. Speed of operation is predetermined and beyond the control of the operator to assure proper operation. Tests have proved the ability of these switches to interrupt twice full rated capacity repeatedly.

Wherever conditions necessitate dependable heavy duty equipment, install Delta-Star's new Dis-ruptor switch. It is by far the most substantial high capacity interrupting switch available.

600 ampere Dis-ruptor . . . with "Amp-trap" fuses.

POSITIVE ARC EXTINCTION

Delta-Star's exclusive arc-ruptor chamber of non-combustible material mounted on each pole quickly and positively extinguishes the arc. Contacts are protected against burning and pitting.

QUICK MAKE-BREAK MECHANISM

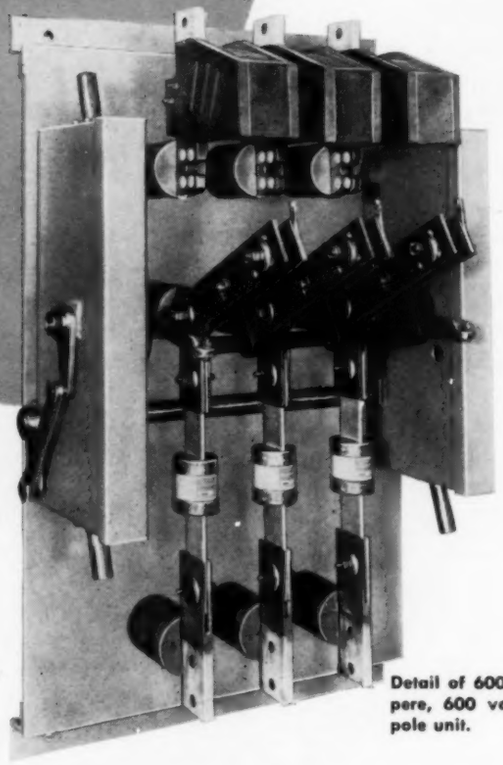
Multiple compression springs put the final act of opening or closing beyond control of the operator. One on each side of the unit, keep the blades in perfect alignment at all times.

HIGH PRESSURE CONTACTS

Self-cleaning, high pressure silver contacts maintain sufficient pressure to carry current efficiently and still permit easy operation.

HEAVY STEEL CABINETS

10 gauge steel cabinets are designed with liberal gutter space for incoming and outgoing conductors. Continuous welded seams and weather-tight gasketed doors exclude dust and corrosive particles. Doors are mechanically interlocked with the operating handle so they cannot be opened until the switch is in the "open" position. With the door open, the switch cannot be closed. All cabinets and operating handles have full provisions for padlocking.



Detail of 600 ampere, 600 volt 3-pole unit.

Ask for Publication 5208

When you visit the Iron and Steel Exposition in Cleveland drop in to see us at Booths 18 and 19.
Our engineers will be happy to discuss your switching problems with you.

DELTA-STAR ELECTRIC COMPANY

DIVISION OF H. K. PORTER COMPANY, INC.

2437 Fulton Street • Chicago 12, Illinois

DISTRICT OFFICES IN PRINCIPAL CITIES

World's Largest Stripper eliminates ingot stickers

The big 400-ton, push-pull, low head room, screw-type Alliance Stripper Crane is equipped with a stripping mechanism that exerts 2½ million pounds of pressure to smoothly strip moulds from ingots. What's more, a retractable bull nose and gripping tongs enable a single operator to make all necessary adjustments to strip either large end-up or small end-up ingots. These special Alliance-engineered features eliminate stickers, make possible tremendous savings in time, moulds and costly alloy ingots.

Alliance . . . world's largest builder of the world's largest cranes . . . makes a habit of offering industry greater strength and lifting versatility. Our big strippers, built with a name plate rating of 400 tons and overload rating of 1200 tons, embody many other exclusive features of design:

- ★ **Special electrical counterweight (counter torque device) developed by The Alliance Machine Company which prevents ingots from falling and inflicting damage to buggies.**
- ★ **No slack cable during stripping operation.**
- ★ **Eliminates the heavy and hazardous counterweights formerly used.**
- ★ **By means of a unique lubricating device, the ample size bronze nut gives many years of trouble-free service.**
- ★ **Special system of spiral bevel and single helical gears results in smoother operation.**
- ★ **All gears are enclosed and run in oil.**
- ★ **Cab that provides the operator with maximum visibility and safety.**

These and many more features are the reasons why it pays to consult Alliance if you're planning for more, newer and better lifting power for your plant. Write today for an analysis of your specific needs.

THE *Alliance* **MACHINE COMPANY**

World's largest builders of world's largest cranes

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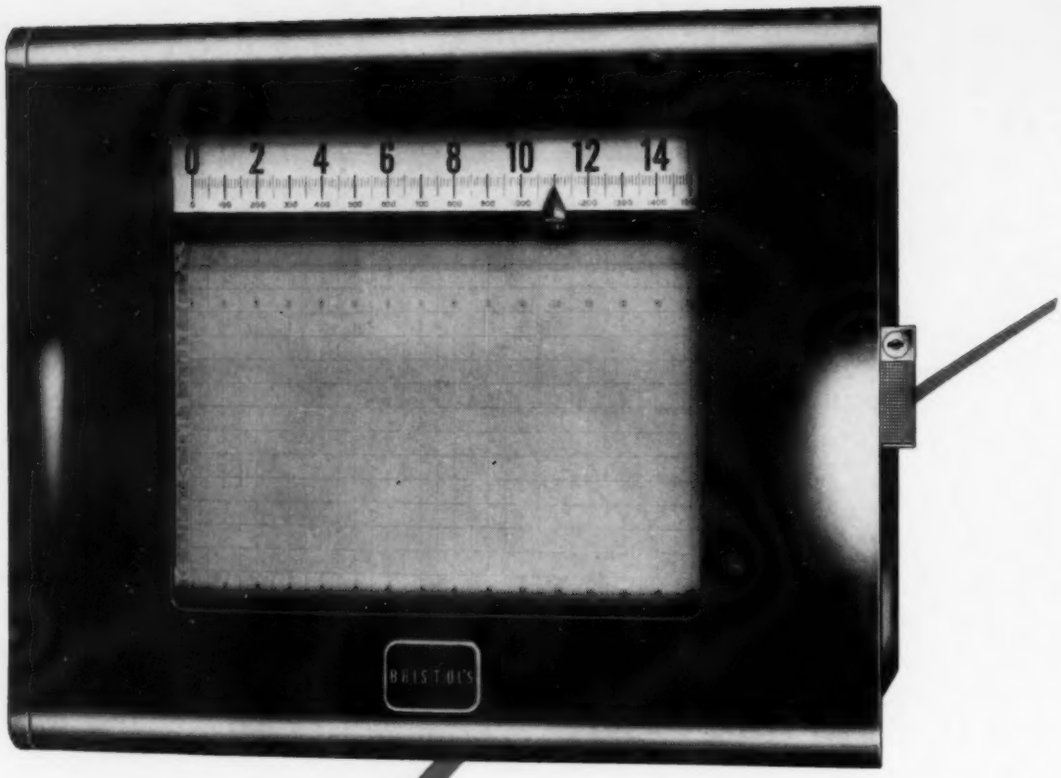
LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION



CHECK the Versatility

of the BRISTOL DYNAMASTER

Electronic temperature recorders and controllers

Dynamasters can be used with "sensing elements" like these:

Resistance thermometers, strain gauges, conductivity cells, thermocouple or radiation pyrometers, tachometer magnetos, pH amplifiers, gas analyzers, X-ray and radiation thickness gauges, photoelectric cells, spectrometers, gas detectors, titrometers, and others

To measure, record and control quantities like these:

Temperature, pressure, volts, amperes, watts, thickness, liquid, flow, liquid level, load, weight, strain, torque, position, conductivity, ionization, rpm, illumination, density, and many others

BRISTOL

The dependable Guidepost of Industry

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

..and Double Check THESE FEATURES:

All types of electric and air-operated controllers offered

Continuous-balancing electronic circuit responds instantly to minute changes

Simple design assures trouble-free operation

Little or no maintenance

Circular or strip-chart models, single or multiple recorders

Electronic component uses vacuum tubes available at any radio supply house

Full-scale pen travel in 2/3, 3, or 7 seconds

Wide variety of chart speeds

Components interchangeable on all Dynamaster models, easily serviced or replaced

Exceptionally unaffected by stray currents (1000 to 1 discrimination)

Available in bridges or potentiometers

Practically immune to shock or vibration

AND THAT'S NOT ALL! *For more details, use the coupon to send for Catalog No. P1245.*

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International Harvester Company
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THE BRISTOL COMPANY
123 Bristol Road
Waterbury 20, Conn.

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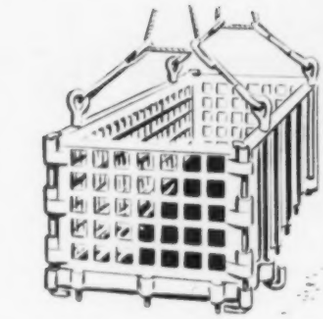
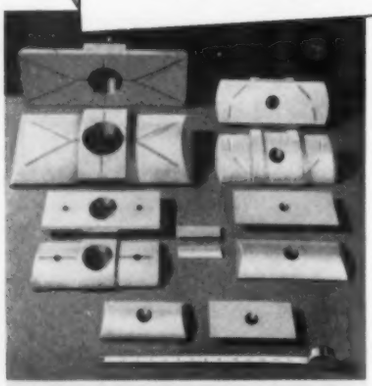
COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____



Pickling Costs Dip...



CAST-TO-SIZE SLIPPERS

Protect your production schedules with wear-resistant Ampco Metal "cast-to-size" slippers. Furnished to $+\frac{1}{32}$" -0", or $-\frac{1}{32}$" $+0$" tolerances with oil-grooves cast-in to requirements. Accurate surface finishes eliminate necessity of machining.

when you use corrosion resistant

AMPCO* METAL

- **to reduce replacement costs**
- **to cut down-time losses**

Ampco Metal crates, baskets, yokes, chains and other pickling equipment meet the "acid-test" with their outstanding resistance to corrosion from sulphuric acid pickling solutions.

Put them to work for you and watch your costs dip and your profits rise. They stay on the job longer, save hours of downtime and hold maintenance, repairs, and replacement to a minimum.

See your nearby Ampco field engineer for complete details about the Ampco alloy that meets your needs best — for pickling equipment and many other steel mill applications where tough, wear-resistant Ampco Metal can save you money.

*Reg. U. S. Pat. Off., Ampco Metal, Inc., Milwaukee, Wis.

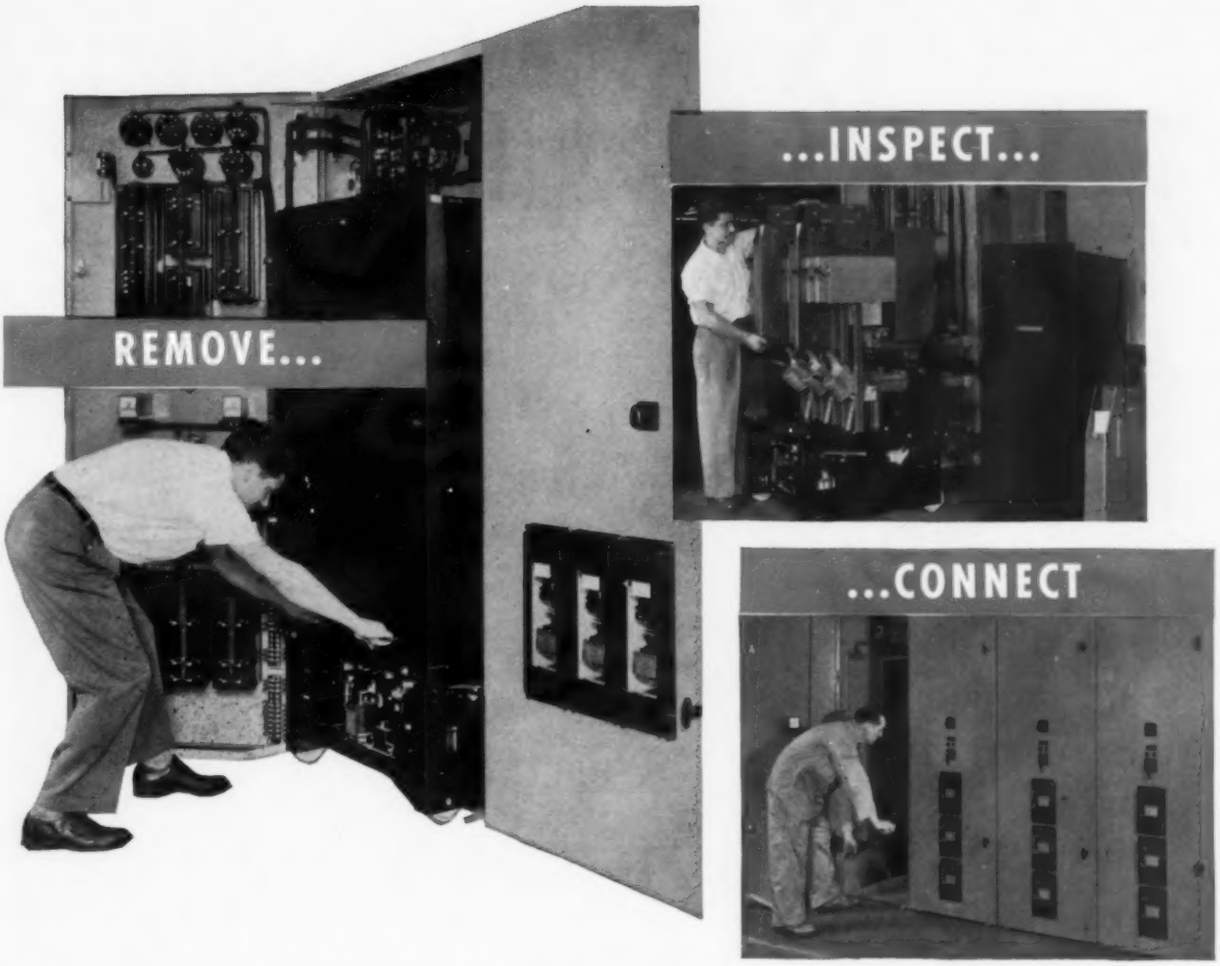
IS-9

AMPCO®

Ampco Metal, Inc.

1710 SOUTH 38TH STREET • MILWAUKEE 46, WIS.

***West Coast Plant:* Burbank, California**



It's easier, faster, safer with Westinghouse horizontal drawout switchgear!

You can remove breakers, inspect them, and replace them in only a few minutes when you use Westinghouse Type DH Metal-Clad Switchgear. Because breakers are drawn out horizontally, no lowering or lifting is necessary. A shutter indicator, visible from the front, provides positive indication of disconnect position. As the breaker is withdrawn, a grounded metal shutter closes to isolate stationary contacts.

When the breaker is removed, interphase barrier and arc chutes remove easily to expose contacts at an accessible and convenient working height for quick inspection.

Replacing the breaker is just as easy and safe. A few easy turns of a crank move the breaker from disconnect to operating position. A mechanical interlock positively prevents engagement of crank linkage unless the breaker is open.

For complete information on Westinghouse Metal-Clad Switchgear for indoor or outdoor service write for Booklet B-5306. Address: Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna.

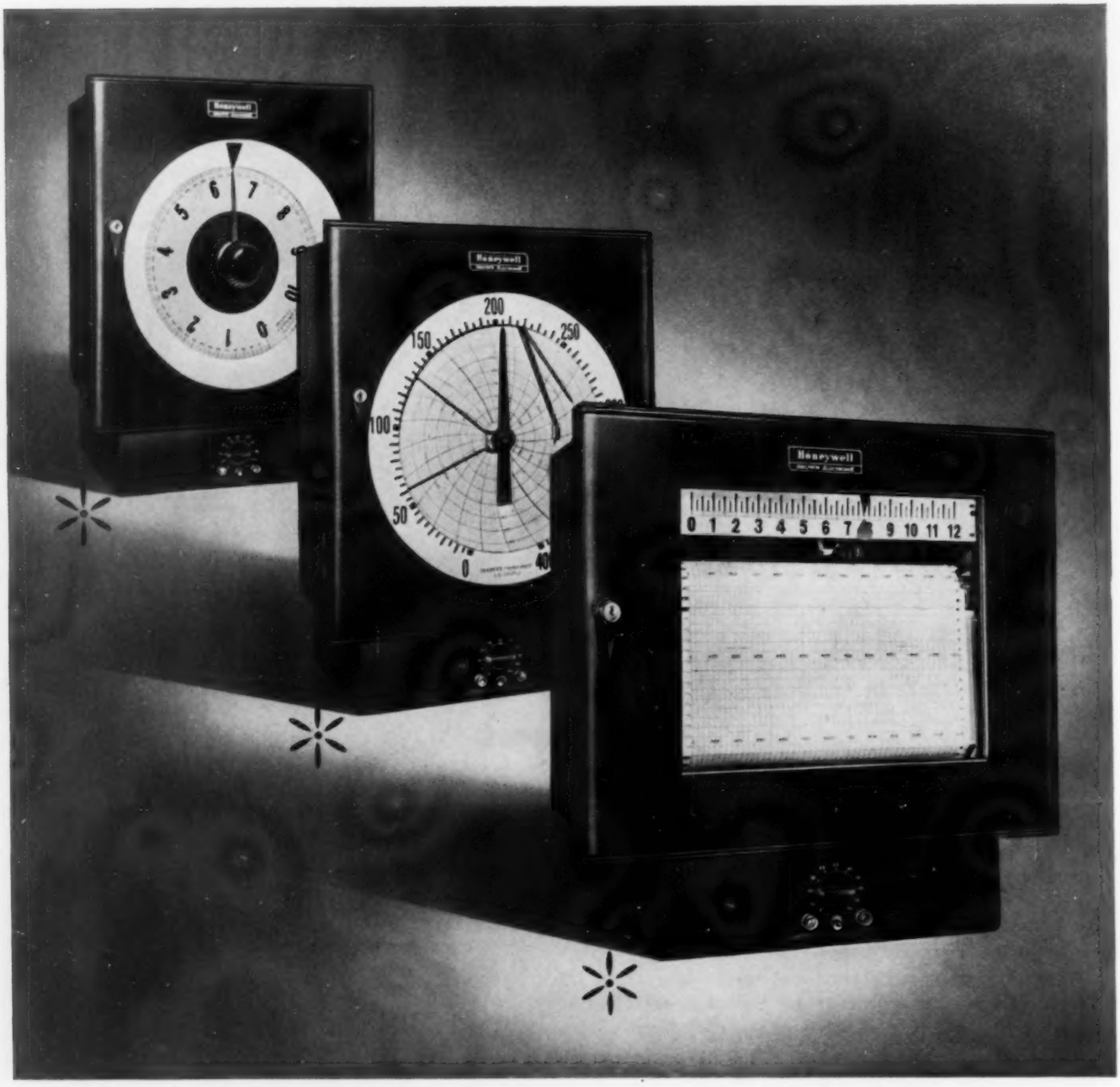
J-60792

DESIGN TESTED AND VERIFIED in the Westinghouse HIGH POWER LABORATORY

YOU CAN BE SURE...IF IT'S Westinghouse

METAL-CLAD SWITCHGEAR

For peak performance . . .



The difference in control action lies in this relay . . . an integral part of the ***ElectroniK*** *Controller. Approach rate adjustment limits overshoot on batch operations.*

. . choose the control that suits your furnace

FOR STRAIGHT LINE TEMPERATURE RECORDS

When heat input should vary like this . . . (LIKE THIS)

...choose

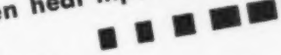
Electr-O-Line

ELECTRIC PROPORTIONAL CONTROL

This position-proportioning electric control delivers continuous heat input; varies the fuel flow by throttling the valve in exact response to changes in heat demand. Both proportional and automatic reset actions are included. Proportional control makes the valve move a large amount for big temperature changes, a small amount for little temperature changes. Automatic reset takes care of variations in load, fuel supply pressure and heat content of fuel.

. . . choose Manual Reset Control *for applications where requirements are less critical. This type has the same position-proportioning action as Electr-O-Line Control, but reset must be manually operated.*

When heat input should vary like this . . .



...choose

Electr-O-Pulse

ELECTRIC PROPORTIONAL CONTROL

Many furnaces need control which supplies fuel at full input, in order to obtain specified heat distribution. For these, as well as for electric furnaces, Electr-O-Pulse Control delivers full heat input in pulses, controlling the ratio of "heat-on" to "heat-off" time to regulate average input as required. This control incorporates both proportional and reset actions. For electric furnaces, it regulates a power contactor. For fuel-fired furnaces, it operates a solenoid or motor-driven valve.

WHETHER your furnace is electric or fuel-fired, big or small, batch or continuous, Honeywell electric proportioning control will assure top quality and maximum output. Here are some outstanding plus values:

Simple installation *— the controller takes little more panel space than a recording instrument, because the control relay is an integral part of the instrument.*

Easy "tuning" *to the requirements of your individual furnace. Each control adjustment is entirely independent. Changes in one do not upset the others.*

Time-saving maintenance *— the entire relay, a compact plug-in unit, can be removed and replaced in a few seconds.*

The control instrument can be an *ElectroniK* strip chart or circular chart recorder, or circular scale indicator. Any of these instrument models can be supplied complete with Electr-O-Line, Electr-O-Pulse or Manual Reset Control. For modernizing existing installations, the control relays are available separately.

Your local Honeywell engineering representative is well qualified to recommend the type of control best suited to your furnace. Call him in today . . . he is as near as your phone.

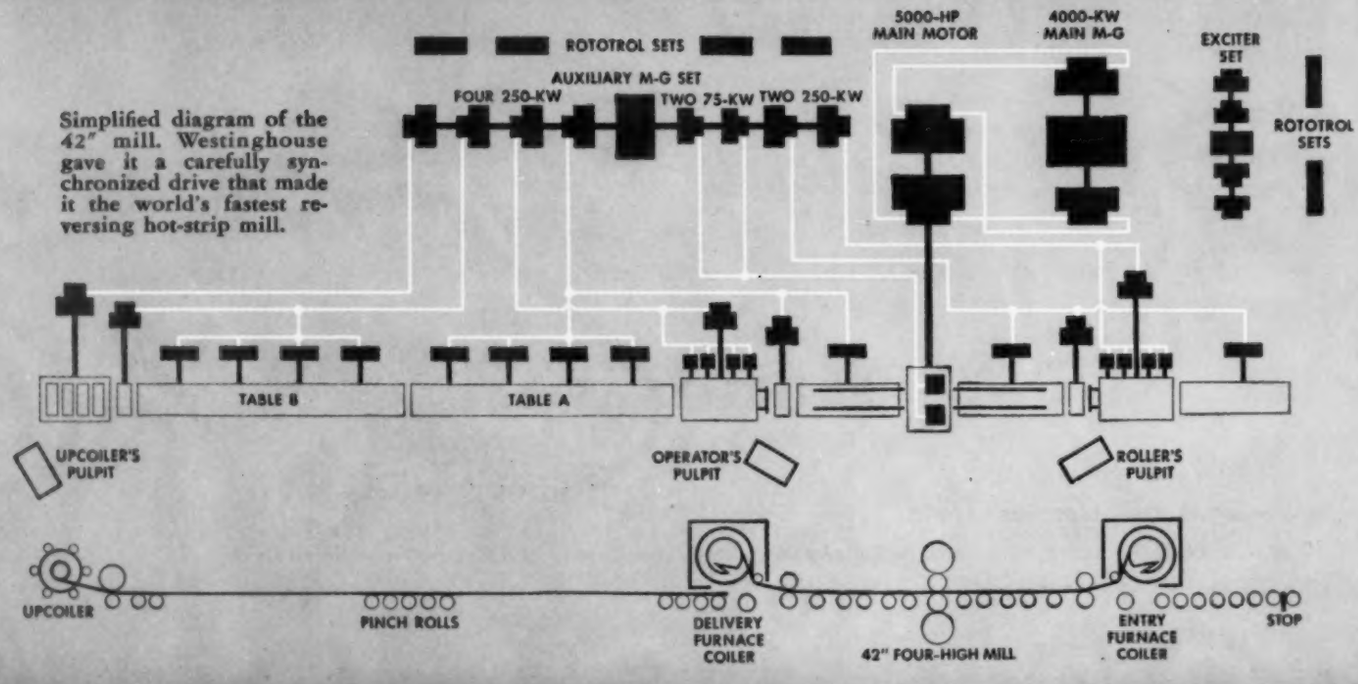
MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4464 Wayne Ave., Philadelphia 44, Pa.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

● ***Important Reference Data***

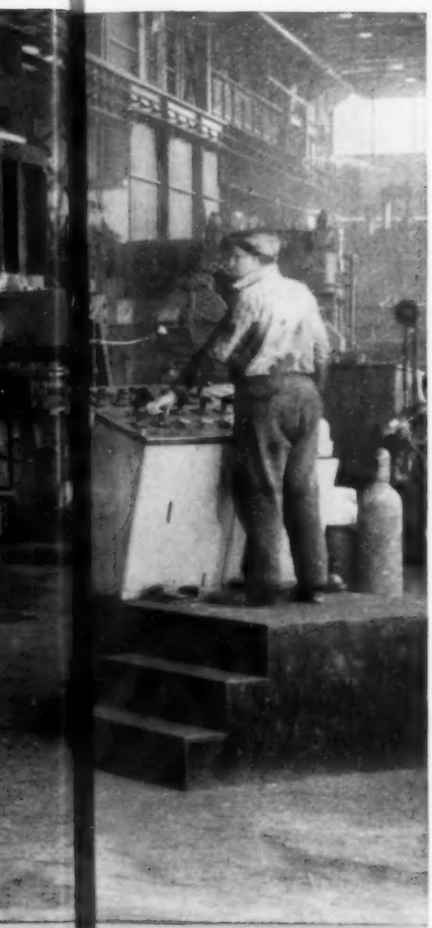
Write for Catalog 15-15, "*ElectroniK* Potentiometers with Electric Contact and Electric Proportional Control."

They did what you can do to produce more



Simplified diagram of the 42" mill. Westinghouse gave it a carefully synchronized drive that made it the world's fastest reversing hot-strip mill.

Can you use hot-strip mill experience like this?



Five of the seven recent reversing hot-strip mill drives in U. S. mills have been built by Westinghouse. Here's a good example—a mill installed in 1949 that was *50% faster* than any previous mill.

An exceptionally high-speed reversing mill

This mill has been highly successful. Theoretical maximum speed is 2,000 fpm and it has operated at more than 1,500 fpm. A complete ingot can be reduced to strip in one piece and the mill regularly produces coils weighing 16,000 to 20,000 lbs. Finished thicknesses range from 0.125″ down to 16 gauge.

Special double-armature motor for main stand

Engineering the drive for this mill presented tricky problems. To accommodate the high speeds and wide speed range, Westinghouse developed a special double-armature motor, each unit of which is supplied by its own d-c generator. Both these generators are driven by a synchronous motor. A second M-G set is used to supply the auxiliary drive.

Main and auxiliary drives synchronized

When the strip leaves the roll stand it races into a narrow groove in a furnace coiler mounted near the mill. This demands the most precise synchronization between main drive and auxiliary drive. Westinghouse answered the need by carefully matching all drive elements and co-ordinating the whole system with Rototrol® regulators.

Call Westinghouse early on your next project

Westinghouse can apply more experience to drives for reversing hot-strip mills than any other manufacturer. And that's typical of our steel mill service. When your next job comes up, call in Westinghouse early.

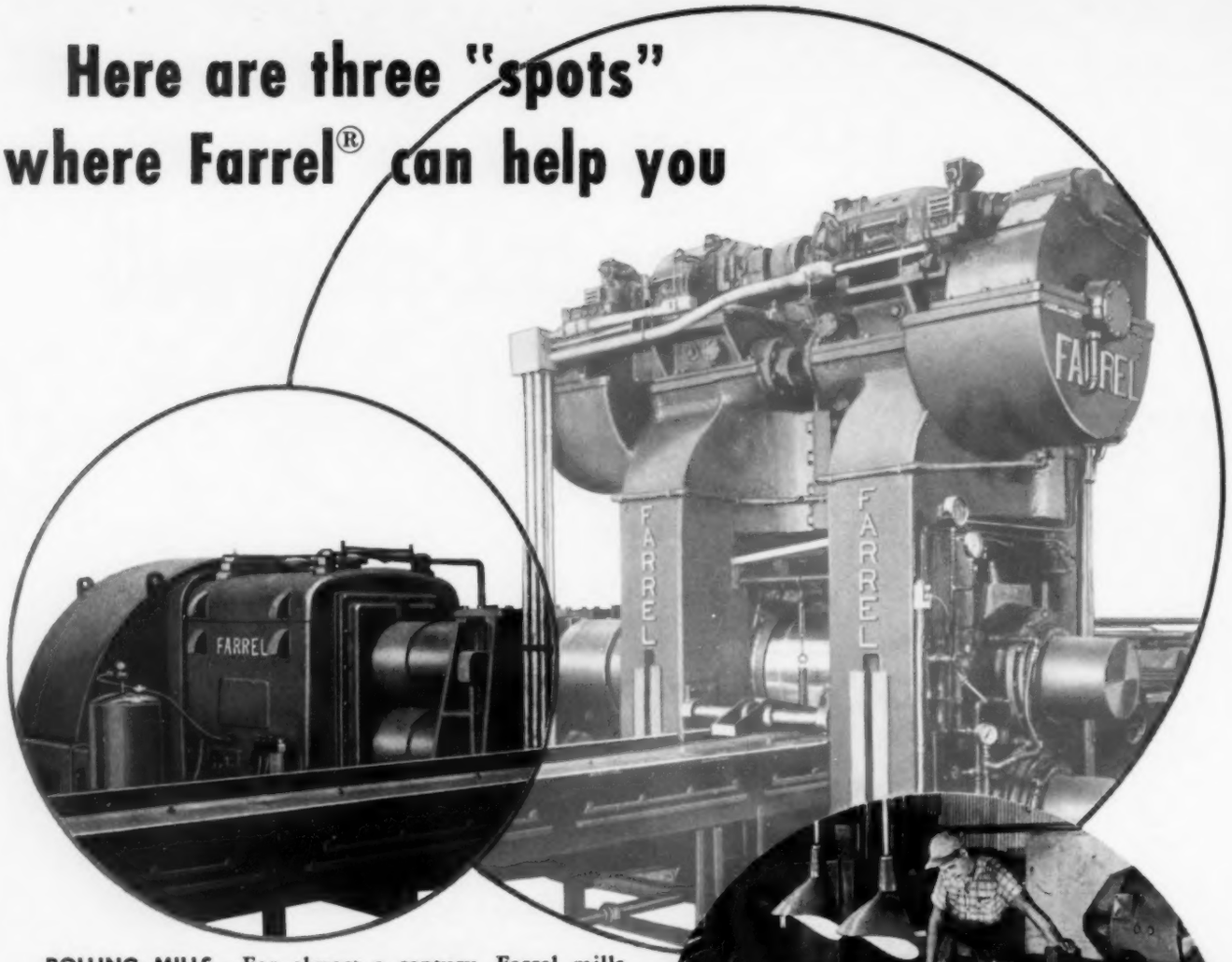
J-94911

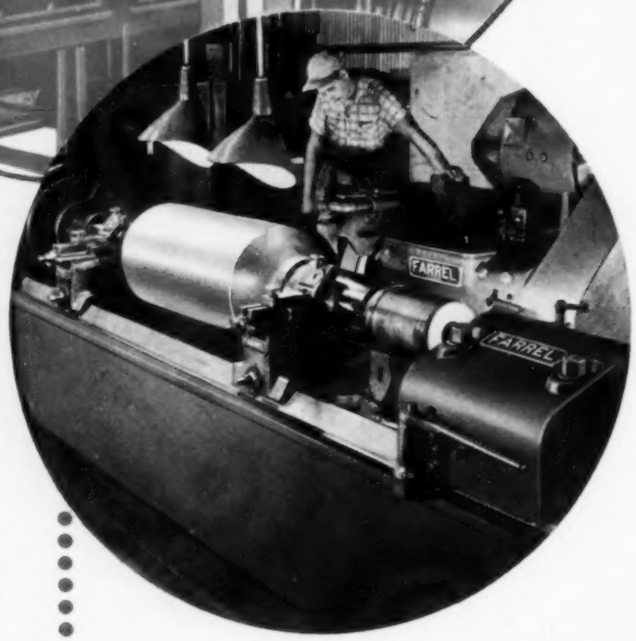
YOU CAN BE SURE...IF IT'S

Westinghouse

EQUIPMENT FOR STEEL PRODUCTION

Here are three "spots" where Farrel® can help you





ROLLING MILLS — For almost a century, Farrel mills have been helping to solve rolling mill production problems. They are built in a wide range of types and sizes for rolling nonferrous rods, strips or sheets, metal foils and cold strip steel. Farrel also designs and manufactures coilers and special handling equipment required to make each installation a complete production unit.

MILL DRIVES — Specially designed to suit individual requirements, Farrel reduction gear drives, pinion stands and combination units are built in any size for any capacity. Combination units have the reduction gears and pinions in a compact, integral housing.

ROLL GRINDERS — Available in two types and nine standard sizes, Farrel roll grinders enable you to fix and maintain definite standards of accuracy and finish. Rolls are produced with a flawless surface, free from marks of any kind, ground straight, or with concave or convex contours of exact symmetry and accuracy.

Information and engineering consultation available, without obligation.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT
Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Akron, Pittsburgh, Chicago, Los Angeles, Houston

FARREL ROLLING MILL EQUIPMENT

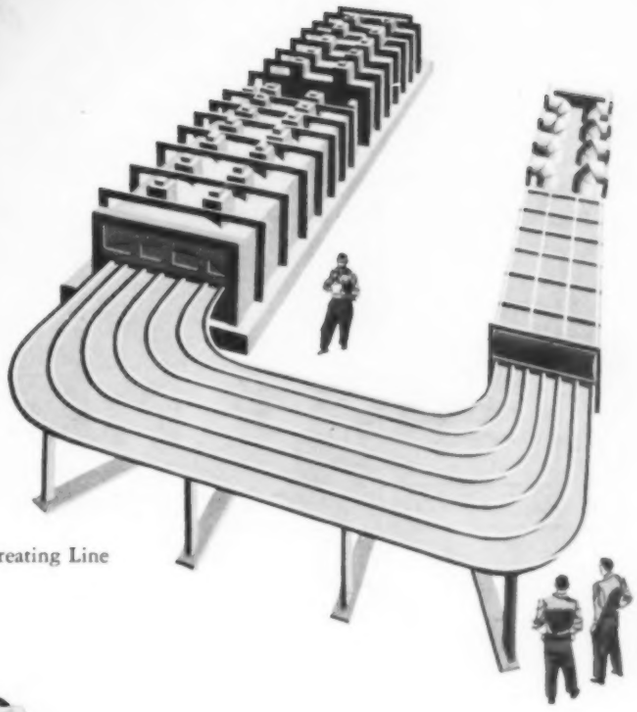
- Rolls
- Rolling Mills
- Mill Tables and Manipulating Equipment
- Universal Mill Spindles
- Rod Coilers
- Gears
- Mill Pinions
- Pinion Stands
- Gear Drives of Any Capacity
- Flexible Couplings
- Roll Grinding Machines
- Roll Calipers

Farrel-Birmingham®

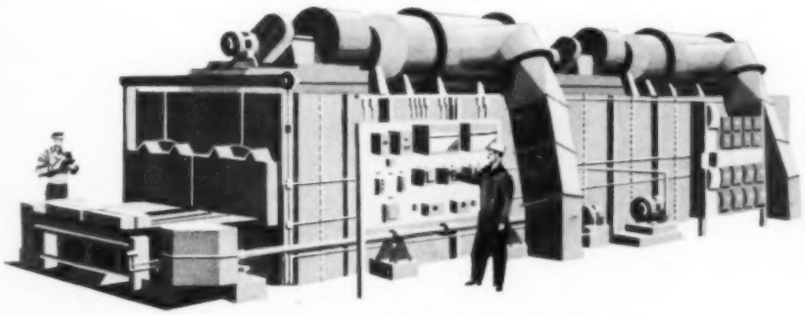
FB-769

Specialists in Furnaces for Defense

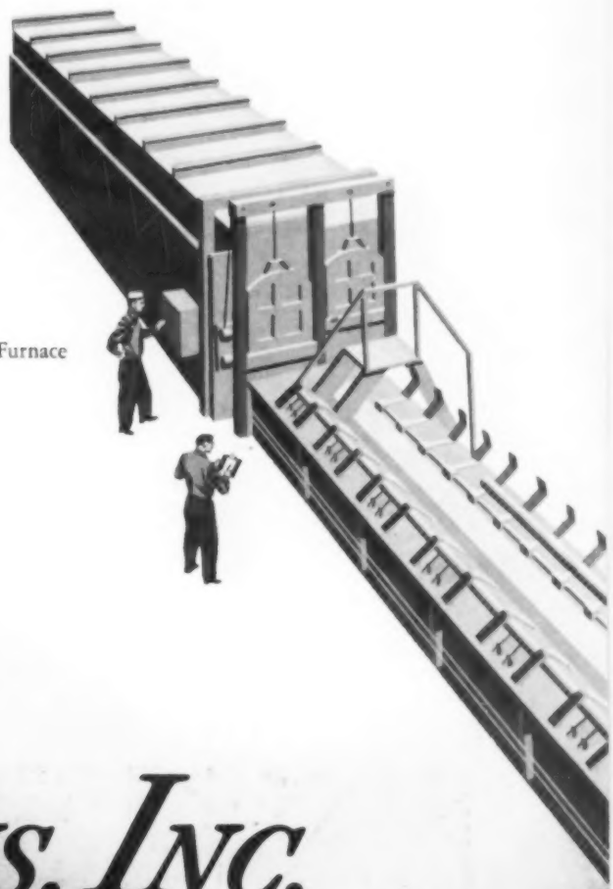
The well-trained and highly-experienced furnace engineers at Salem-Brosius have designed and built a great many eminently successful furnaces for heating and heat treating ordnance and aircraft parts. As a result, they are known as specialists in the field. Though, among them, they have produced just about every type of heavy furnace in use today, they take certain pride in their reputation for producing defense units. It implies some assistance in building America's strength. You'll find that a Salem-Brosius Defense Furnace cuts cost and adds production because it is excellently designed, well constructed, and contains many special features not elsewhere available.



Shell Heat Treating Line



Aluminum Billet Heating Furnace



Gun Barrel Hardening Furnace

Remember, if you have a problem that involves the use of industrial furnaces, blast furnace equipment, or charging and manipulating machines, it will pay you to call on Salem-Brosius today.

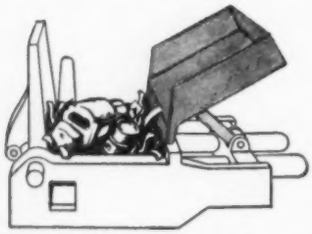
SALEM-BROSIUS, INC.

SALES AND EXECUTIVE OFFICES: 248 FOURTH AVENUE, PITTSBURGH 22, PA.

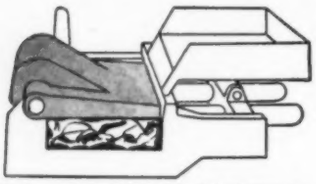
BROSIUS DIVISION, PITTSBURGH 15, PA. SALEM ENGINEERING DIVISION, SALEM, OHIO

5 to 15% Greater Open Hearth Production...

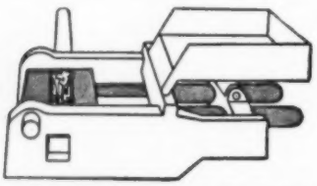
Lindemann "SA" Press handles bales weighing 4 tons or more



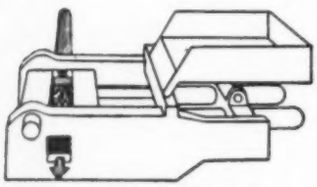
1. Scrap fed into the hopper by crane is tipped into press box by tilting action of hydraulically-controlled hopper.



2. Hydraulically-driven lid closes to exert first stage of scrap compression. Press box accommodates bulky, lengthy scrap – and lid shears off overhanging pieces against serrated edges of press box.



3. Half-pressure ram now effects second stage of compressing scrap into a dense bale. Hopper is being refilled for next baling cycle.



4. Final-pressure ram presses bale into final form and automatically ejects it directly into charging box—or onto slideway landing at furnace platform.

Keep scrap moving *quickly, economically* with Lindemann Baling Presses

with Lindemann triple-action "SA" Presses

One *automatically ejected* bale fills entire charging box—steps up open hearth production, cuts down charging, handling and melting costs.

You can press bales as big as 8,800 *pounds—large enough to fill the whole charging box with a single bale—when you use a Lindemann Hydraulic "SA" Press. You need fewer boxes—you save charging time.*

Large charging opening of the press box allows feeding of very long, bulky scrap. Hydraulically operated hinged lid shears off overhang against patented serrated bars on box edges. *Hinge action increases press box capacity by* 40%.

Bale is automatically ejected into charging box or onto slideway landing—no cranes needed. Large feeding hopper allows filling for next bale during pressing operation—no idle time.

Main cylinders are horizontal, allowing easy access and maintenance. No deep, costly foundation pits are needed.

Press box sizes from 80" x 71" x 32" to 157" x 177" x 50". Bales weights from 900 to 8,800 pounds; rates up to 31 per hour.

LOOK INTO THESE OTHER LINDEMANN PRESSES, *TOO!*

Other Lindemann Lid-Type Presses are designed to meet the needs of electric and blast furnaces, car body works, large metal-working plants, large and small scrap dealers.

Patented Shearing Ram Presses combine functions of scrap shear and baling press—do away with preliminary shearing or oxygen cutting.

Just tell us the business you're in —and amount and type of scrap you handle. We'll send you literature on Lindemann Presses that meet your needs.

Spare parts available at our Cleveland Service Center

KO CO., INC INDUSTRIAL IMPORTERS

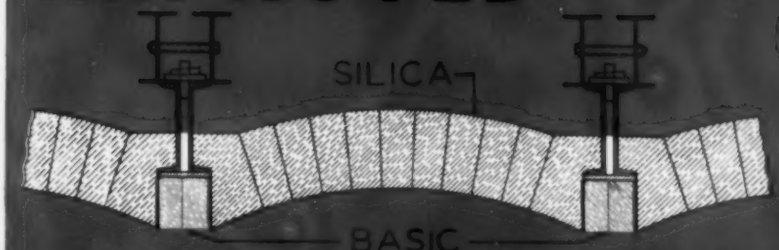
KURT ORBAN

COMPANY, INC.

205 East 42nd St., New York 17 • 4220 Prospect Ave., Cleveland 3 • 19450 James Couzens Highway, Detroit 35

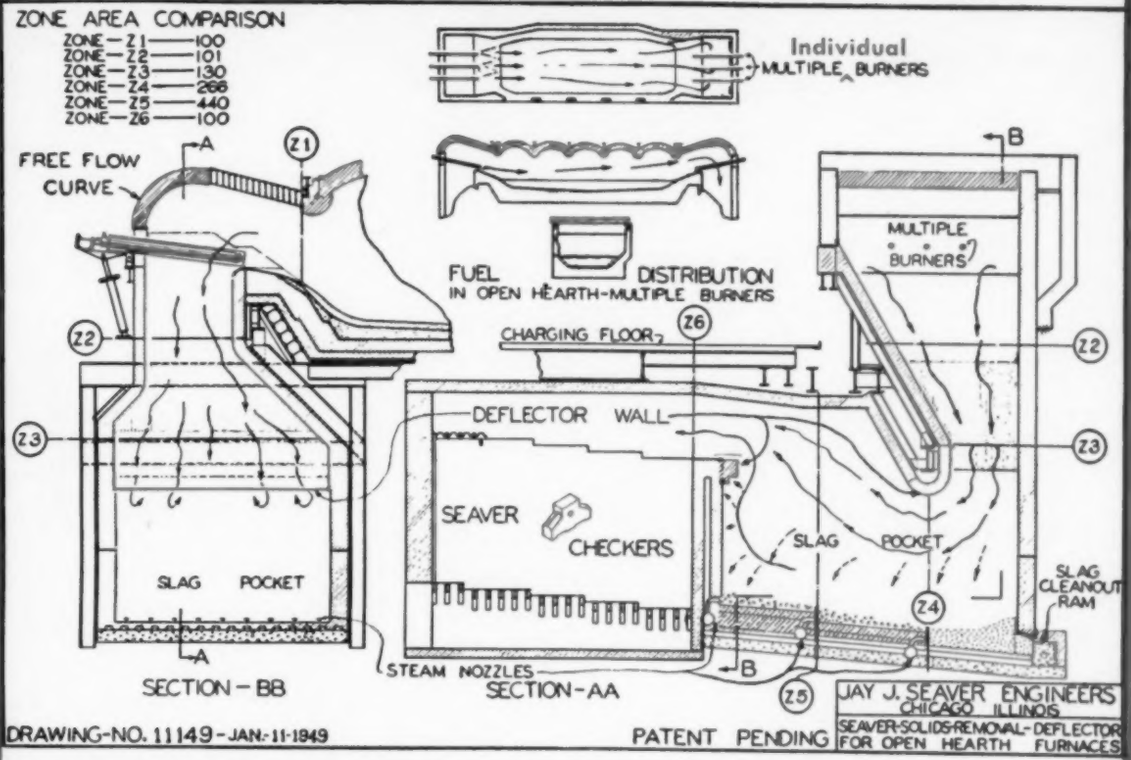
JAY J. SEAVER ENGINEERS

IMPROVED OPEN HEARTH DESIGNS



with CAMEL BACK ROOF

Advantages of Basic Roof at Price of Silica



SEAVER FEATURES

Save on Tap to Tap Time
with faster charging and faster melt down.

Save on Fuel
Increased heat recovery; improved combustion.

- Solids Removal Deflectors
- Multiple Individual Burners
- Continuous Slag Removal
- Large Self-Sealing Doors
- Improved Reversing and Air Valve Equipment
- Increased Checker Heating with SEAVER Cross-Vent Checkers
- Elimination of Checker Lancing

DEEP STEPPED SLAG POCKETS

WRITE TODAY for blueprints and further information. We shall be happy to show you how existing open hearth furnaces can be altered or new furnaces built to secure these cost-saving advantages.

COMPLETE SERVICE TO THE IRON AND STEEL INDUSTRY

Consulting — Design — Construction — Reports — Appraisals — Investigations —Management and Operation—Thirty-Five Years Experience in the Industry

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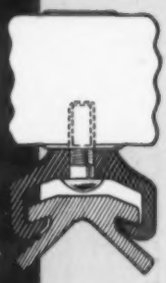
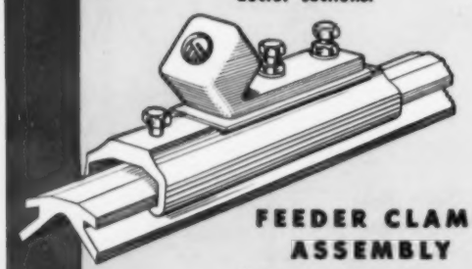
The Keystone INTEGRATED ALUMINUM* Conductor System



HANGER SECTION
Conductor free to slide within support, allowing for expansion and contraction.

JOINT PLATE AND BOND ASSEMBLY
Non-loosening spring-type splice plate provides excellent electrical and mechanical joint characteristics between conductor sections.



FEEDER CLAMP ASSEMBLY
features a bimetal separator that eliminates galvanic corrosion between copper terminal and aluminum surface, providing foolproof, long-lasting connection.

LOWER COST

LIGHTER WEIGHT, HIGHER EFFICIENCY

SAFER ENCLOSURES

An integrated power supply system designed to complement the best materials handling equipment—1000 amperes capacity for heavy duty systems . . . economical for use on control circuits.

The Keystone Aluminum Conductor System is now being employed in outstanding installations, after having been developed through years of research in the laboratory and industry. It has been carefully designed to solve the troublesome problems formerly encountered.

The light weight of this conductor system reduces costs of installation, insulators and supporting structures. Its non-corrosive qualities permit use on sensitive control circuits. Longer contact life. Compact design saves space, permits better protection. All components are pre-fabricated. Available complete with brackets and enclosures. No copper boosters nor priorities needed. Easily engineered, installed and maintained.

*Domestic and Foreign Patents Pending

Write today for new, illustrated 4-page folder on Keystone Integrated Aluminum Conductor System.

ELECTRIC SERVICE MANUFACTURING CO.

PHILADELPHIA 32, PENNA.

better measurement and control of

TEMPERATURE

−350°F to +2800°F

Throughout the vast field of industrial temperature instrumentation, Foxboro will be found in the greatest number of installations where complete reliability and most economical fulfillment of optimum accuracy are vital. If your process requires temperature measurement or control in any range between —350°F. and +2800°F., the high engineering standards and complete diversity of Foxboro Instruments . . . backed by Foxboro's unequaled application experience . . . offer you the way to obtain it most effectively.

INDICATORS • RECORDERS • CONTROLLERS

electric, electronic and pressure-filled thermal systems

TRANSMISSION SYSTEMS • CONTROLLED VALVES

FOXBORO

Reg. U. S. Pat. Off.

For over 40 years, specialists in the measurement and control of temperature, pressure, flow, liquid level, humidity . . .

THE FOXBORO COMPANY • FOXBORO, MASSACHUSETTS, U.S.A.

Harbison-Walker Refractories for every type of furnace in the iron and steel industry

The conditions that affect the life and service of iron and steel furnaces are many and differ widely. To provide the exact kinds of refractories that will enable steel producers to maintain maximum production with greatest economy under all these varying conditions, Harbison-Walker offers the complete range of types and classes for every specific requirement.

Harbison-Walker Refractories Company

AND SUBSIDIARIES

WORLD'S LARGEST PRODUCER OF REFRACTORIES

General Offices . . . . . Pittsburgh 22, Pennsylvania

HARBISON-WALKER

THE WORLD'S *Most Complete* REFRACTORIES SERVICE

SPECIALIZED REFRACTORIES

for IRON and STEEL producers

BLAST FURNACE REFRACTORIES

For more than half a century, Harbison-Walker Blast Furnace Refractories have been the leading choice of the industry. The major portion of linings currently installed in the United States, Canada, and Mexico are Harbison-Walker brands.

VARNON BF—extremely hard-fired, super-duty fireclay brick, having high strength and density, low porosity and permeability, immunity to disintegration by carbon monoxide, high refractoriness and resistance to slagging.

H-W 18 Pa. and H-W 18 Ky.—hard-burned, high duty fireclay brick. Exceptionally resistant to abrasion, and to disintegration by carbon monoxide. H-W 18 brick are low in permeability and porosity, have high mechanical strength and excellent volume stability at working temperatures.

BENEZET BF and H-W Ky. BF—for many years the standard refractories for most blast furnaces—for hearth and bosh, inwall and top linings.

BLAST FURNACE STOVE REFRACTORIES

Harbison-Walker brands of high duty and super-duty fireclay refractories fulfill all the exacting requirements for stove linings, domes and checkers.

OPEN-HEARTH and ELECTRICAL STEEL FURNACE REFRACTORIES

STAR SILICA—The long established silica brick. Characterized by high refractoriness, rigidity under load at high temperatures, good resistance to abrasion and fluxing.

VEGA—the super-duty, high temperature silica brick especially suited for extremely severe operating conditions.

VEGA BOND—super-duty silica bonding mortar of excellent workability and super-duty refractoriness; thermal expansion entirely compatible with that of silica brick.

CHROMEX B—extremely hard burned chrome-magnesite brick with excellent volume stability and strength at high temperatures.

CHROMEX—a chemically-bonded chrome-magnesite brick having excellent spalling resistance.

METALKASE—a chemically-bonded metal-encased magnesite-chrome brick. Dense, strong, slag resisting and low spalling tendency.

H-W MAGNESITE—the standard burned magnesite refractory in the steel industry for more than fifty years.

H-W CHROME—a hard burned chrome brick especially adapted for various specific uses.

H-W MAGNAMIX—a magnesite ramming mixture for monolithic bottoms and for patching. Easily installed to the desired contour with great saving in time.

OTHER Iron and Steel Furnace REFRACTORIES

For the widely diversified furnace applications, Harbison-Walker provides refractories which meet every need. These include high-alumina brick of all classes; super-duty and other classes of fireclay refractories; insulating fire brick; high temperature bonding mortars and ramming mixtures; plastics and castables.

Harbison-Walker Refractories Company

AND SUBSIDIARIES

WORLD'S LARGEST PRODUCER OF REFRACTORIES

General Offices . . . . . Pittsburgh 22, Pennsylvania

DRAVO
DESIGNERS and BUILDERS
BRIDGES AND UNLOADERS • TOWER-TYPE UNLOADERS
WHIRLER CRANES • FLOATING CRANES
DRAVO RAIL CLAMPS • BARGE SHIFTERS
MODERNIZED TROLLEYS FOR EXISTING BRIDGES
BALTIMORE & OHIO RAILROAD's new modern import pier at Curtis Bay in Baltimore has capacity for handling 2000 tons of 200-lb. ore per hour. The two cantilever steel unloading towers and the 895-ft. conveyor system, insure rapid, continuous and economical handling of ore from ship to hopper car.
Why not make use of Dravo's more than 60 years of practical experience in many engineering fields when planning your next heavy material-handling project?
DRAVO
CORPORATION
NEVILLE ISLAND, PITTSBURGH 25, PENNSYLVANIA

FARRELL-CHEEK CRANE WHEELS

Serve Four to Eight Times Longer!

Reports from users of Farrell-Cheek pressure-cast steel crane wheels say they get from four to eight times longer service than with other types of wheels. You can have the same performance on your cranes. We can quickly give you the reasons for using F-C wheels.

F-C wheels stand up to continuous hard use because they are made with the finest available materials in a completely modern plant. Farrell's famous steel alloy "85" offers a superb combination of physical properties — high yield strength, toughness, hardness, and high resistance to wear and abrasion. Another special alloy, F-C Hard Edge, protects critical surfaces against wear. Also, F-C wheels have been designed and tested to withstand both static and impact loads. The records of hundreds of installations show they perform even beyond the high standard indicated by their fine materials, and expert design and manufacture.

F-"85"

F-"85" is a special purpose cast steel which can be heat treated through selective processing. Treads and flanges are toughened and hardened for maximum resistance to shock and abrasive wear.

HARD EDGE

Hard Edge tests from 500 to 650 Brinell, is used on treads and flanges in a depth ranging from 1/8" to 3/16" depending on size of wheel. It is backed up with a softer steel alloy with a Brinell of from 285 to 315.

Either standard or special designs can be furnished. You can save yourself the cost of frequent wheel replacements by starting now to use Farrell-Cheek crane wheels. Write today for detailed information.

FARRELL-CHEEK STEEL CO.

MANUFACTURERS OF HIGHEST QUALITY ELECTRIC FURNACE CARBON AND ALLOY STEEL CASTINGS

FARRELL'S CARBON STEEL CASTINGS
FARRELL'S HARD EDGE STEEL CASTINGS
FARRELL'S "85" STEEL CASTINGS

RAILROAD CASTINGS
Locomotive and Car R. R. Specialty Castings.

ELEVATOR, CONVEYOR PARTS
Sprockets, Traction Wheels, Chains, Buckets, Rollers, Idlers.

BUSHINGS
Carbon and Alloy Steels Machined, Hardened, Ground.

CRANE WHEELS
Overhead, Gantry, Monorail, Ingot Car, Charging Machine.

GEARS AND PINIONS
"True Tooth" Gears and Pinions, Sheaves and Wheels.

SPECIALIZED CASTINGS
Light Section Castings.

STOKER PARTS
Feed Screws, Furnace Tools, Flanged Pipe, etc.

HEAVY HARDWARE
Wire Rope Fittings, Choker Hooks, Bar Benders, Cutters.

YOUR INQUIRY WILL PROMPTLY BRING DETAILED INFORMATION PERTAINING TO ANY OF THE ABOVE FARRELL-CHEEK PRODUCTS

• • • SANDUSKY, OHIO U.S.A.

Protect the plant and

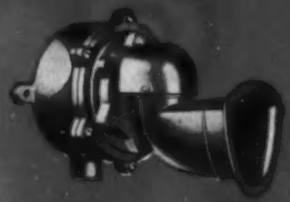
with CROUSE-HINDS

. . . . . bells, horns, sirens, and visual signals

Raintight signals for non-hazardous locations

The most complete line

Type WH Raintight Horn with Grill



Type WH Raintight Horn with Single Projector

Type WH Raintight Horn with Double Projector

Type PS Raintight Pilot Light Conduiet

Continuous production is of vital importance in successful plant operation. Costly shutdowns can often be avoided by Crouse-Hinds signals that give an instant warning of abnormal operating conditions or sound an alarm in case of fire.

A wide variety of signals is necessary to meet the varied conditions in industry. Crouse-Hinds offers a comprehensive line of signaling devices for plant protection and communication . . . . . sirens, horn, bells, and visual signals. Each unit is designed with individual characteristics that make it superior for a particular kind of service. There are Crouse-Hinds signals for use in non-hazardous locations; raintight signals for use where exposed to the weather; explosion-proof and dust-tight signals for use in hazardous locations; signals with a low volume of sound and high power signals that are extremely loud.

You have a definite advantage in selecting signals from the all-inclusive Crouse-Hinds line. It is possible for you to meet the requirements of every location. In noisy areas the character of the noise is of first importance. A signal producing a sound having the greatest contrast to the area noise should always be selected. For example, a horn would not be suitable in

A Nationwide Distribution Through Electrical Wholesalers

CROUSE-HINDS COMPANY
Syracuse 1, N. Y.

OFFICES: Birmingham — Boston — Buffalo — Chicago — Cincinnati — Cleveland — Dallas — Denver Detroit — Houston — Indianapolis — Kansas City — Los Angles — Milwaukee — Minneapolis New Orleans — New York — Philadelphia — Pittsburgh — Portland, Ore — San Francisco — Seattle St Louis — Tulsa — Washington RESIDENT REPRESENTATIVES: Albany — Atlanta Baltimore — Charlotte — Corpus Christi — Richmond, Va. Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.

CONDULET
REG. U.S. PAT. OFF.
First in the field
STANDARD OF QUALITY

CONDULETS · TRAFFIC SIGNALS · AIRPORT LIGHTING · FLOODLIGHTS

maintain continuous production

Signaling Devices

for control of operations, and fire protection.

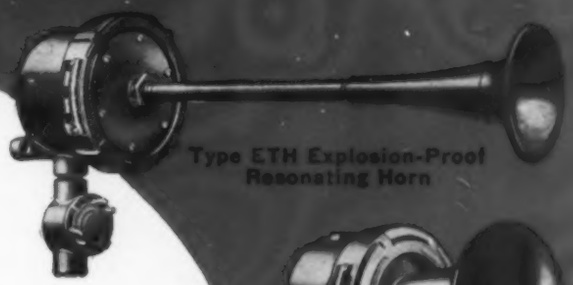
of explosion-proof and dust-tight signals for hazardous locations

surroundings where a constant hum or whine is present but a bell could readily be heard. A bell would be inadequate in surroundings where the noise is produced by hammering on metal but a horn would give the required contrast.

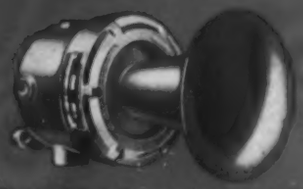
Careful consideration should also be given to the number of signals required. In general, much better coverage is obtained by even distribution of several low output units than by one or two high output units. On the other hand, a high powered unit is necessary when the sound must be projected a considerable distance from one location.

Crouse-Hinds' line of visual signals includes a variety of pilot lights and also the Visularm, a compact unit used to supervise manufacturing processes. The Visularm will automatically indicate normal and abnormal temperature, liquid level, speed, load, or any other condition which can be electrically coupled to the circuit. An independent circuit is provided in the Visularm to actuate an audible signal.

In Crouse-Hinds' complete line there are dozens of different units from which to choose the items to meet your particular requirements. They are all listed in the Crouse-Hinds Condulet Catalog.



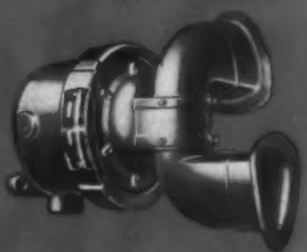
Type ETH Explosion-Proof Resonating Horn



Type ETH Explosion-Proof Standard Volume Horn

Type ETH Explosion-Proof Siren

Type ETH Explosion-Proof High Power Horn with Grill



Type ETH Explosion-Proof High Power Horn with Double Projector

Type EGP Explosion-Proof Panel-Mounting Switch and Pilot Light Condulet

Type EFD Explosion-Proof Pilot Light Condulet

Three Type EKP Explosion-Proof Visularms. One cover removed. Rear view of panel.

Type ESR Explosion-Proof Bell

Now they're MOVIE STARS

These outstanding Heavy Bulk Materials Handling installations are featured in the new Heyl & Patterson industrial film "Modern Materials Handling." Don't miss this fascinating film that tells the handling and transportation story of coal and ore from mine to blast furnace.

The World's Fastest Coal Barge Unloader

"The Giant with the Gentle Hands"

The Finest Coal and Ore Bridge Ever Built

See the installations illustrated on this page and other H & P Heavy Bulk Materials Handling Equipment IN ACTION at the Iron & Steel Exposition . . .

BOOTHS 494 and 495

Make the Heyl & Patterson booths one of your "for sure" stops.

This new Heyl & Patterson industrial film, "Modern Materials Handling" is now available for showings to industrial and engineering groups. Film is 16 mm. with sound and color.

If you are interested in showing this film, write to the Advertising Department of Heyl & Patterson, giving the name and address of your organization, and the date on which you wish to show the film. There is no charge, of course, other than postage.

Heyl & Patterson, Inc.

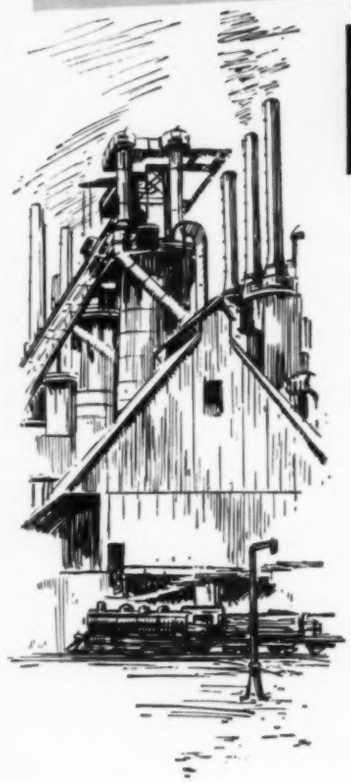
"SINCE 1887"

55 WATER STREET · PITTSBURGH 22, PA.

Heavy Bulk Materials Handling Equipment

All The Way from Design to Erection

FOR MOST EFFECTIVE STEEL MILL LUBRICATION SYSTEMS

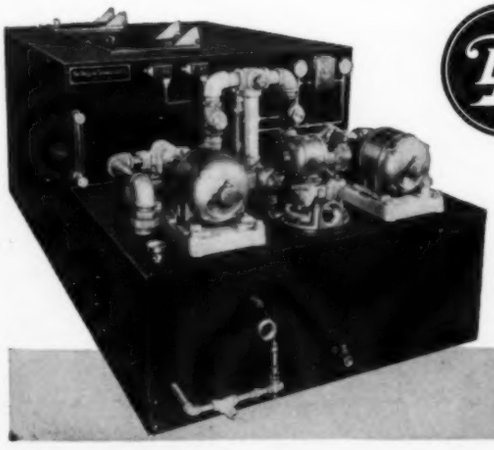


...DE LAVAL

De Laval lubrication systems for steel mills are all engineered to include four things:

1. **Correct Metering of Lubricant**
   De Laval Systems stress supplying each bearing and gear mesh point with exactly the right amount of lubricant. A constant streamline flow of lubricant in the correct quantity and pressure must be maintained at all times.
2. **Proper Selection of Pipe Size**
   The proper selection of pipe size is important to provide efficient lubrication. All De Laval Systems are designed to keep the pressure drop due to line friction at a minimum, and to insure a streamline flow.
3. **Efficient Temperature Control**
   De Laval Systems incorporate a constant control of the lubricant temperature both winter and summer. By the use of efficient heating or cooling facilities, a continuous flow of lubricant at the correct temperature and viscosity is maintained.
4. **Purification of Lubricating Oil**
   De Laval Oil Purifiers, furnished as part of the design where possible, are permanently piped to the system to permit centrifugal by-pass purification of the lubricant in service. The Purifiers remove water and fine solid contaminants.

The size of the mill does not matter. For large mills, De Laval designs "cutom-built" systems; for small mills, a De Laval "Uni-Lube," self-contained unit with a circulating capacity up to 50 gpm, is available. ***Send for Bulletin 500.***



THE DE LAVAL SEPARATOR COMPANY
Poughkeepsie, New York 427 Randolph St., Chicago 6
DE LAVAL SALES & SERVICE, INC.
447 Fourth Ave., Pittsburgh 19
DE LAVAL PACIFIC COMPANY
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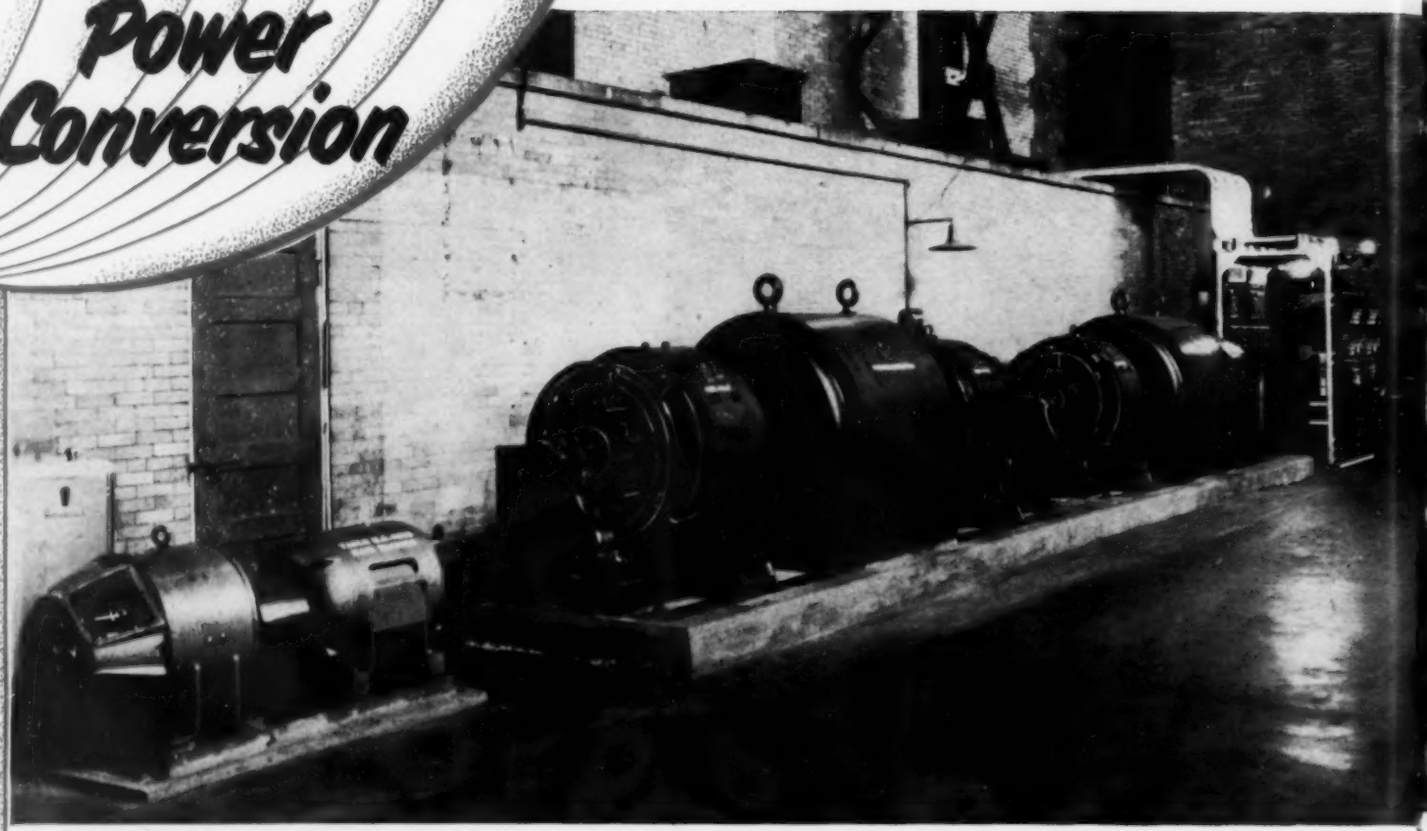
DE LAVAL

ENGINEERED SYSTEMS

It's ELLIOTT on this slabbing

Power Conversion



The two Elliott 400-kw motor-generator sets, each consisting of a 600-hp, 1480-rpm, 6600-volt, 25-cycle, squirrel cage induction motor driving two 200-kw, 250-volt dc generators which furnish variable voltage power to two W-618 Elliott Mill Motors such as shown on opposite page. Excitation motor-generator set at extreme left. Cutler-Hammer control at extreme right applied by Elliott for complete co-ordination.

...another Elliott

Here is another typical example of Elliott engineering co-ordination, quality craftsmanship, and rugged construction, combined to provide the utmost in reliable performance. Shown on these pages are Elliott generators and motors engineered to serve the front and rear tables of a 44" slabbing mill at the South Chicago Works of United States Steel Company . . . a service which is a true test of ruggedness, of reliability, and of adaptability to exacting service.

Elliott
FABRI-STEEL
MOTORS AND GENERATORS

DEPT. 15
RIDGWAY DIVISION
RIDGWAY, PA.

ELLIOTT

PLANTS AT: JEANNETTE, PA. • RIDGWAY, PA. • AMPERE, N. J.
DISTRICT OFFICES IN

T at both ends g mill table drive

Power Application

Two of the four W-618, 200-hp Elliott Crocker-Wheeler Mill Motors which drive the roll tables. These motors are designed, with associated equipment, to accelerate the 24 rolls per table from standstill to rated motor speed in from 2 to 2.8 seconds.

t job well done!

The heavy mill table application of the two motors in the photo above is an indication of the conditions under which they operate. They are Elliott Crocker-Wheeler Mill Motors — built to take the abuse of heavy overloads, reversing strains, heat, dust, fumes, and other conditions that could be calculated to search out and expose any motor failing. They are tough motors, proving their toughness in hundreds of applications as difficult as that shown above.

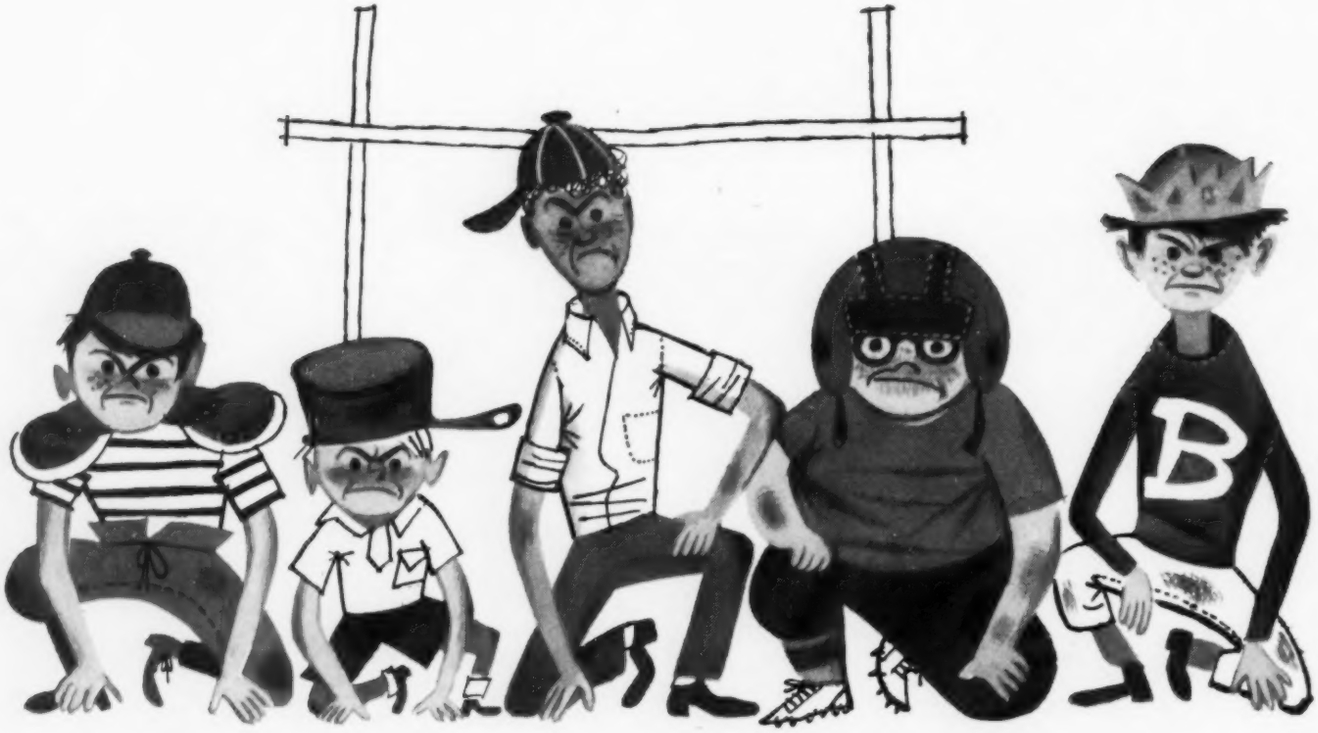
MR-10a

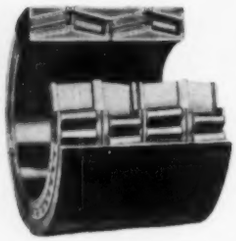
Company CROCKER-WHEELER DIVISION

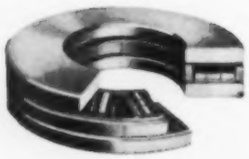
• SPRINGFIELD, O. • NEWARK, N. J.

PRINCIPAL CITIES

AMPERE, N. J.







all types...

Many builders and users of mechanical equipment have found the answer to their anti-friction bearing needs at Torrington which makes all basic types.

Torrington spherical roller, tapered roller, straight roller, needle and ball bearings are available in a wide variety of sizes. And when a standard type "won't do", Torrington designs special bearings tailored to the job.

So whether you need an unbiased recommendation for the standard bearing best suited to your application or a special bearing, Torrington is always ready to serve you. Call the office nearest you.

THE TORRINGTON COMPANY

Torrington, Conn. South Bend 21, Ind.

District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON BEARINGS

Spherical Roller • Tapered Roller • Straight Roller • Needle • Ball • Needle Rollers

SQUARE D FIELD ENGINEERING

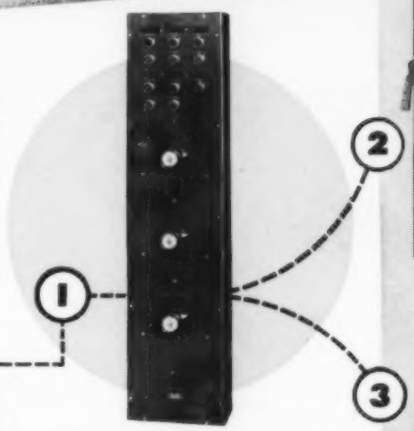
in Action!

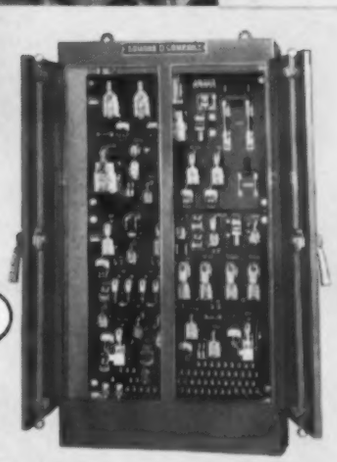
Landis Tool Precision Roll Grinder at the United Engineering & Foundry Company, Vandergrift, Pa.

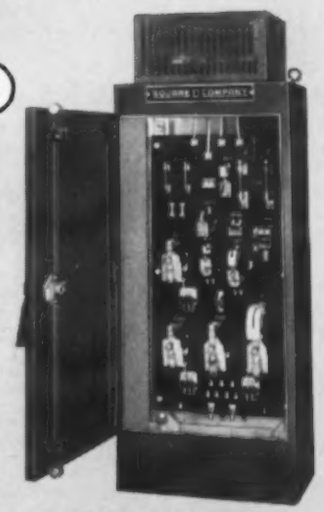
PROBLEM: To design an electrical control system for a Landis Tool 60" x 192", Type 30 roll grinder with eight D.C. motors.

Master control station on traveling carriage to control all functions.

No trailing cables between floor and carriage. Minimum number of trolley wires. Rigid space limitations on carriage mounted equipment.







SOLUTION:

Square D Heavy Duty D.C. Control Panel and Master Control Station on carriage with interlocked, floor-mounted control panel for work drive motor.

Control circuit developed with field switching feature requiring only 1 control trolley and 2 power trolleys. (Normally 6 to 8 trolleys would be required.) *All* floor-to-carriage flexible *cables eliminated.* Space limitations met without sacrifice of electrical clearances or protective features.

1. Master Control Station, mounted on traveling carriage.
2. Carriage-mounted Controller starts, accelerates and stops these motors: wheel drive, carriage traverse, ways lubrication pump, spindle lubrication pump, wheel in and out rapid movement, coolant pump.
3. Floor-mounted Controller for starting, stopping and speed control of work drive motor.

Square D Field Engineers Are at Your Service Through Branch Offices in All Principal Cities

SQUARE D COMPANY

DETROIT · MILWAUKEE · LOS ANGELES

SQUARE D COMPANY CANADA LTD., TORONTO • SQUARE D de MEXICO, S.A., MEXICO CITY, D.F.

How TIMKEN® bearings hold down screwdown maintenance

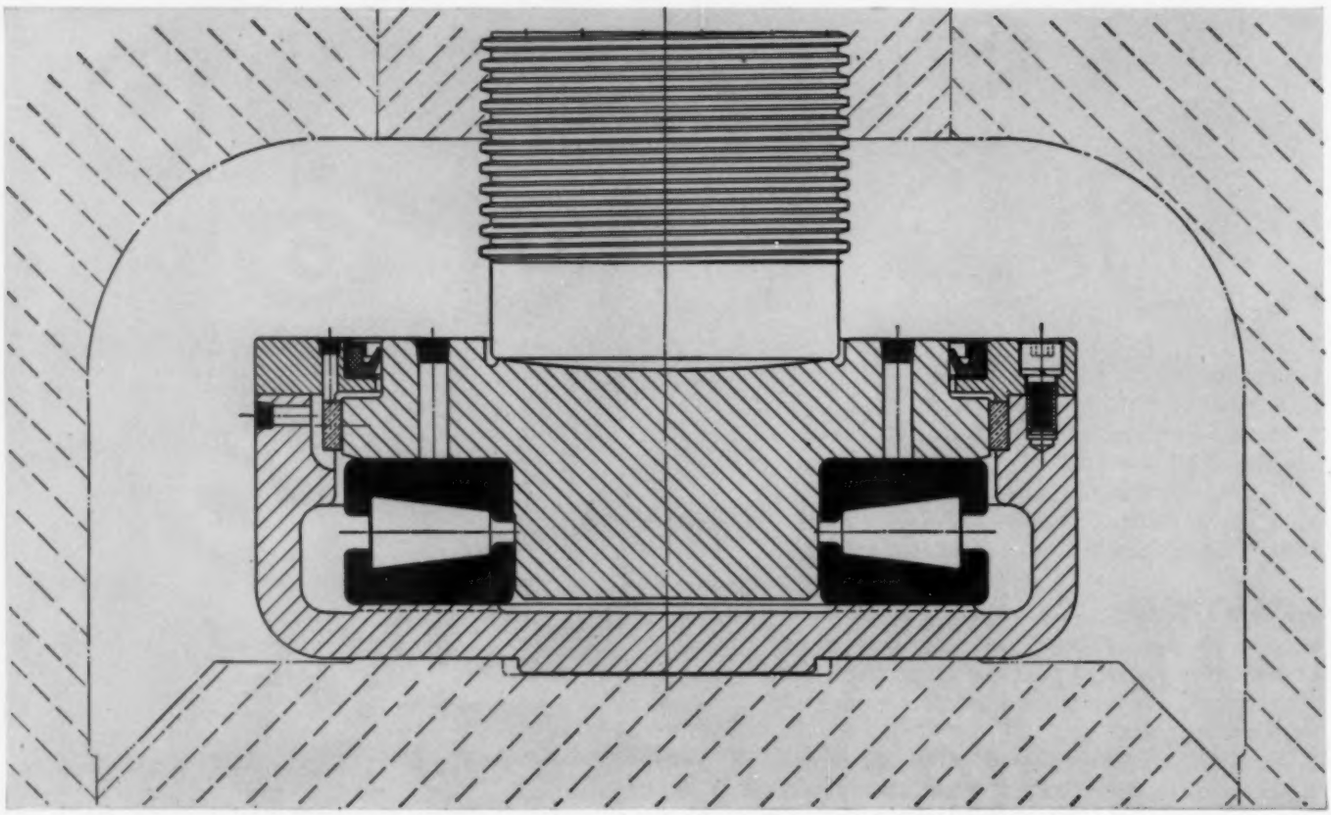
WITH Timken® flat thrust bearings installed on cold mill breaker blocks, screwdown maintenance is virtually eliminated. Timken flat thrust bearings take the terrific screw loads with minimum friction. Motor overload is drastically reduced, screwdown response is quick and uniform. There's no stripping of worm gears, no costly time-outs for lubrication.

Line contact between rollers and races of Timken bearings provides extra load-carrying capacity. Their incredibly smooth surface finish practically eliminates friction. On-apex construction gives them true rolling motion, eliminates skidding and skewing of the rollers.

Timken bearings are made of the finest steel ever developed for tapered roller bearings—Timken fine alloy steel. And they're case-carburized to give them hard wear-resistant surfaces and tough, shock-resistant cores.

No other bearings give you all the advantages you get with Timken bearings. Always specify them for the machines you build or buy. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable Address: "TIMROSCO".

This symbol on a product means its bearings are the best.



Drawing shows how Timken flat thrust bearings are mounted on the breaker blocks of a 4-high cold mill to hold down screwdown maintenance and assure long, dependable operation.

DESIGN LEADERSHIP

The first Timken tapered roller bearing was produced in 1898. Since then the one-piece multiple perforated cage, wide area contact between roller ends and ribs, and every other important tapered roller bearing improvement have been introduced by The Timken Roller Bearing Company.

The Timken Company leads in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis steels.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ◯ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ◫ AND THRUST →◫← LOADS OR ANY COMBINATION →✳←

TSP
File hard and full depth case for super resistance to surface wear.
Super refined soft, tough, and ductile core for maximum strength. Actual customer service records, comparing "Tool Steel Process" rolls with competitive rolls, definitely prove that TSP rolls, operating under the severest service conditions, are tremendously superior in both the desired finish and lowest final cost per ton produced.

It is important that you receive the proper rolls for your special requirements. Tool Steel's world-wide reputation in metallurgy and heat treatment, plus their years of experience in manufacturing rolls for cold processing of metals, gives you this assurance.

Write today for your free copy of Tool Steel's comprehensive Roll Bulletin No. 152.

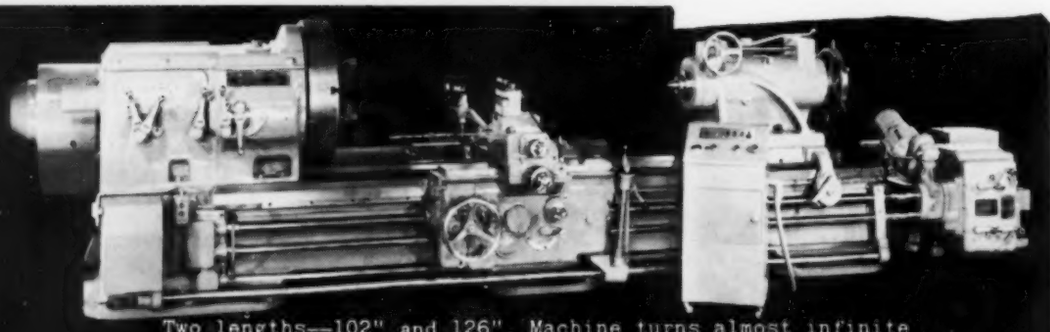
TOOL STEEL PROCESS PRODUCTS
. . . the products that carry an absolutely positive GUARANTEE to give a longer life in the same service than any other product.

THE TOOL STEEL GEAR AND PINION CO.
CINCINNATI 16, OHIO, U. S. A.

THE STANDARD OF QUALITY SINCE 1909 FOR GEARS • PINIONS • ROLLS • WHEELS AND OTHER HARDENED PRODUCTS

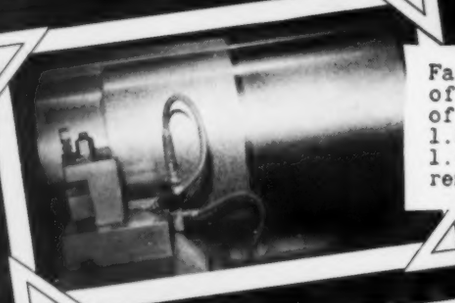
A SNAP FOR STEEL PRODUCERS!

This Tracer-Controlled Monarch Heavy Duty Roll-Turner Produces 3 to 6 Times Faster! Offers Many Other Great Advantages.



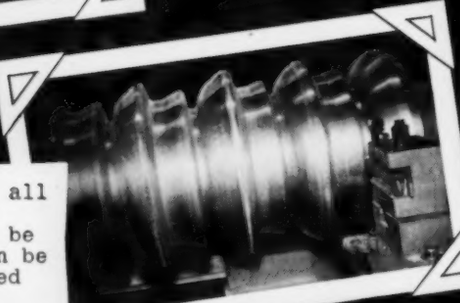
Two lengths—102" and 126". Machine turns almost infinite variety of shapes—necks on same setup. Max. swing—25".

1st HOUR



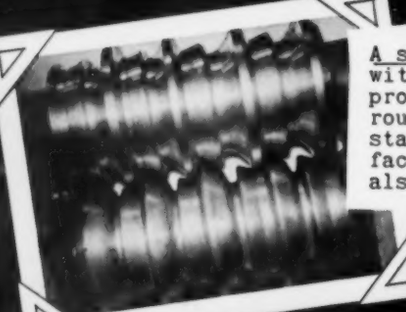
Facing begun on first of pair of rail section rolls. Body of roll—40-1/2". Rolls are 1.56% carbon, 0.77% nickel, 1.13% chromium. Total metal removed, 3730 lbs. per roll.

10th HOUR

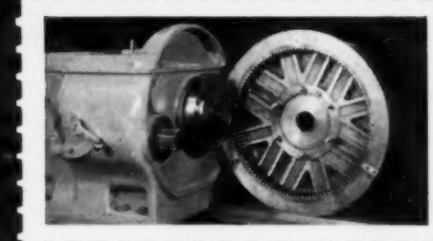


Roughing completed. With all rolls from given template identical, rolls need not be matched in pairs. One can be redressed or new one turned with assured match.

26th HOUR



A savings of 99 hours compared with conventional roll lathe production. Both rolls faced, roughed and finished. Only standard carbide round nose and facing tools used—a huge savings also in form tool inventory.



TOP – Another typical operation.

CENTER – Face plate removed. Power applied far from work axis on large diameter rolls.

BOTTOM – Complete push button control exclusive with Monarch.

Focus on Monarch for all your turning needs.

Monarch
TURNING MACHINES
ACCURACY • ECONOMY • LONG LIFE

FOR A GOOD TURN FASTER
...TURN TO MONARCH

THE MONARCH MACHINE TOOL CO., SIDNEY, OHIO
Please send me without obligation your complete illustrated Heavy Duty Roll-Turner Booklet No. 1302.

NAME _____ TITLE _____

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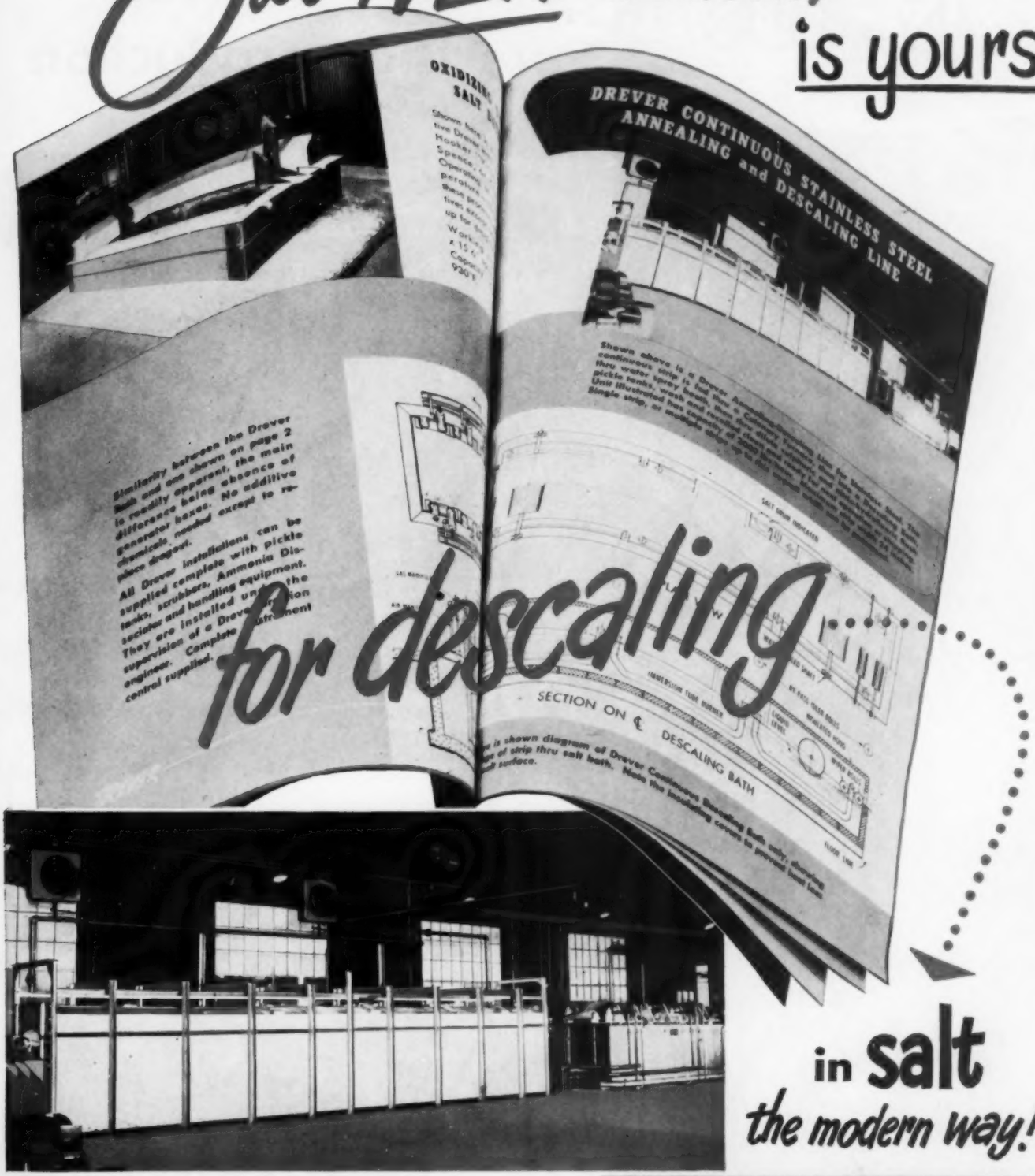
Our NEW bulletin is yours



for descaling

in salt the modern way!

3

Continuous or Batch Type Descaling Lines with Automatic Temperature Control.

— Write for Bulletin B-40

DREVER CO.

730 E. VENANGO STREET • PHILADELPHIA 34, PA.

LEWIS ROLLS . . . . . are designed for precision production

"X" and "XA"

AJAX DUPLEX ROLLS

SPECIAL PROCESS ROLLS

SPECIAL TUBE MILL ROLL

CLIMAX and AJAX ROLLS

ATLAS and ATLAS "B" ROLLS

MOLYBDENUM CHILLED IRON ROLLS

The mark of the PERFECT ROLL

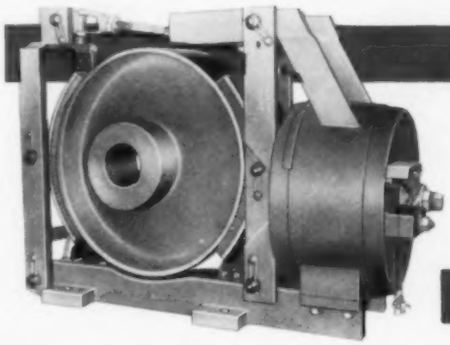
MANUFACTURERS OF
ROLLS AND ROLLING MILL EQUIPMENT
FOR THE IRON, STEEL AND
NON-FERROUS
INDUSTRIES

LEWIS FOUNDRY AND MACHINE DIVISION OF BLAW-KNOX COMPANY • PITTSBURGH, PA.

CLARK ENGINEERED MILL APPARATUS

SAVES $ $ For You

All CLARK Mill Control Apparatus is built not only for heavy-duty service, but also engineered for simple and easy maintenance.



SIMPLICITY

One adjustment corrects lining wear and magnet air gap at the same time on CLARK Shoe Brakes. All adjustments are made at the *top*—not at bottom, sides or ends, but *ON TOP*, where you can see and get at the job. Self aligning shoe guides automatically maintain the shoes in concentric position, eliminating tipping and dragging.

RUGGEDNESS

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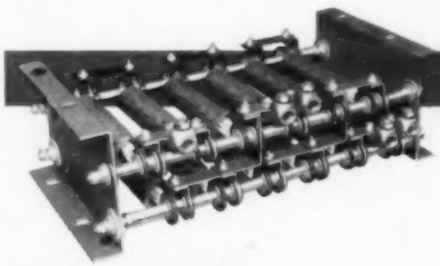

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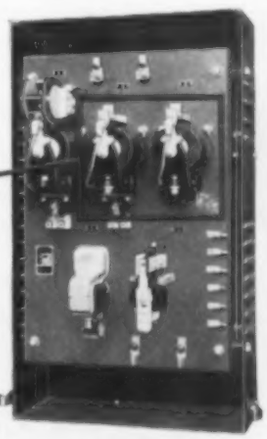

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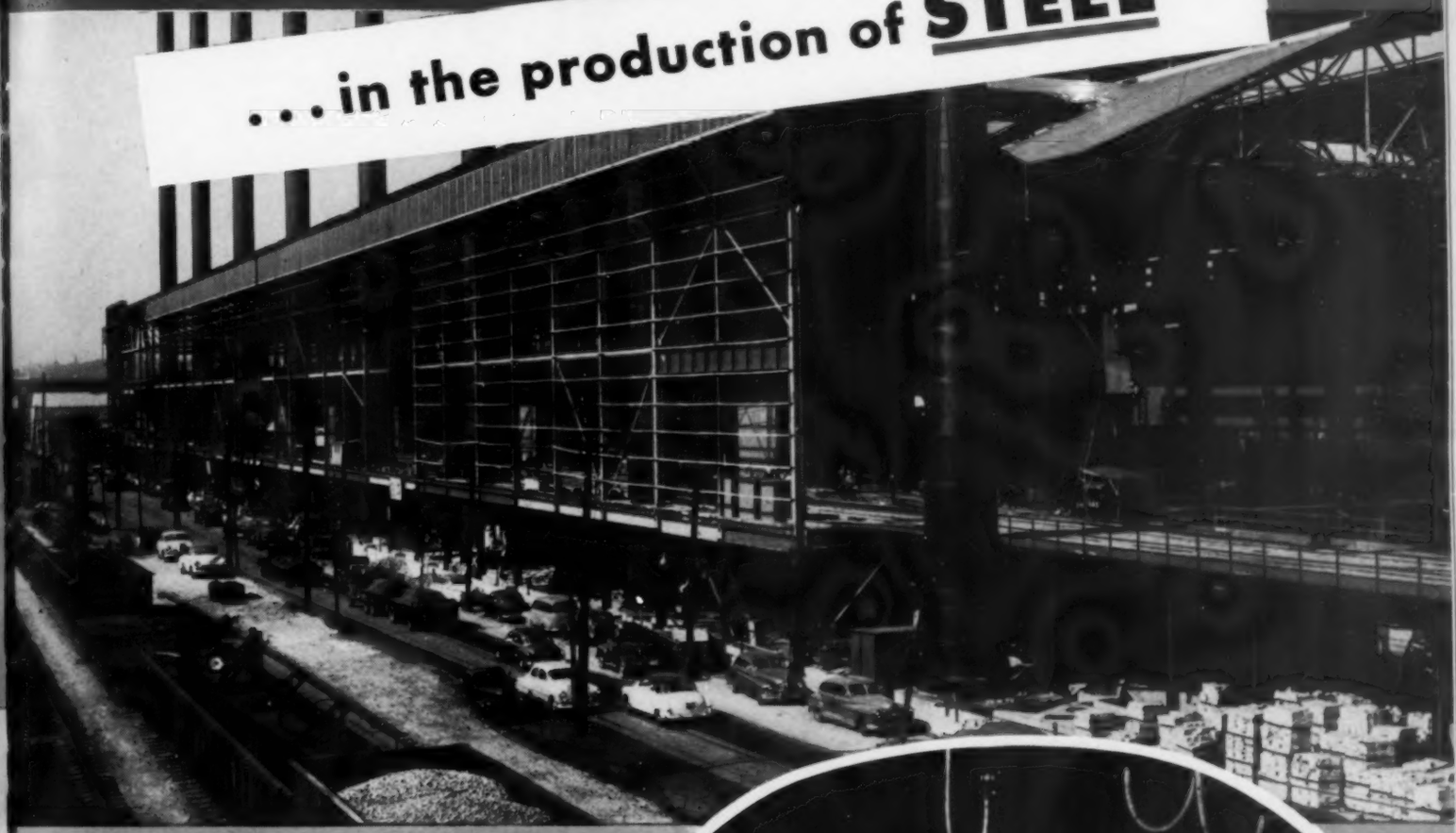

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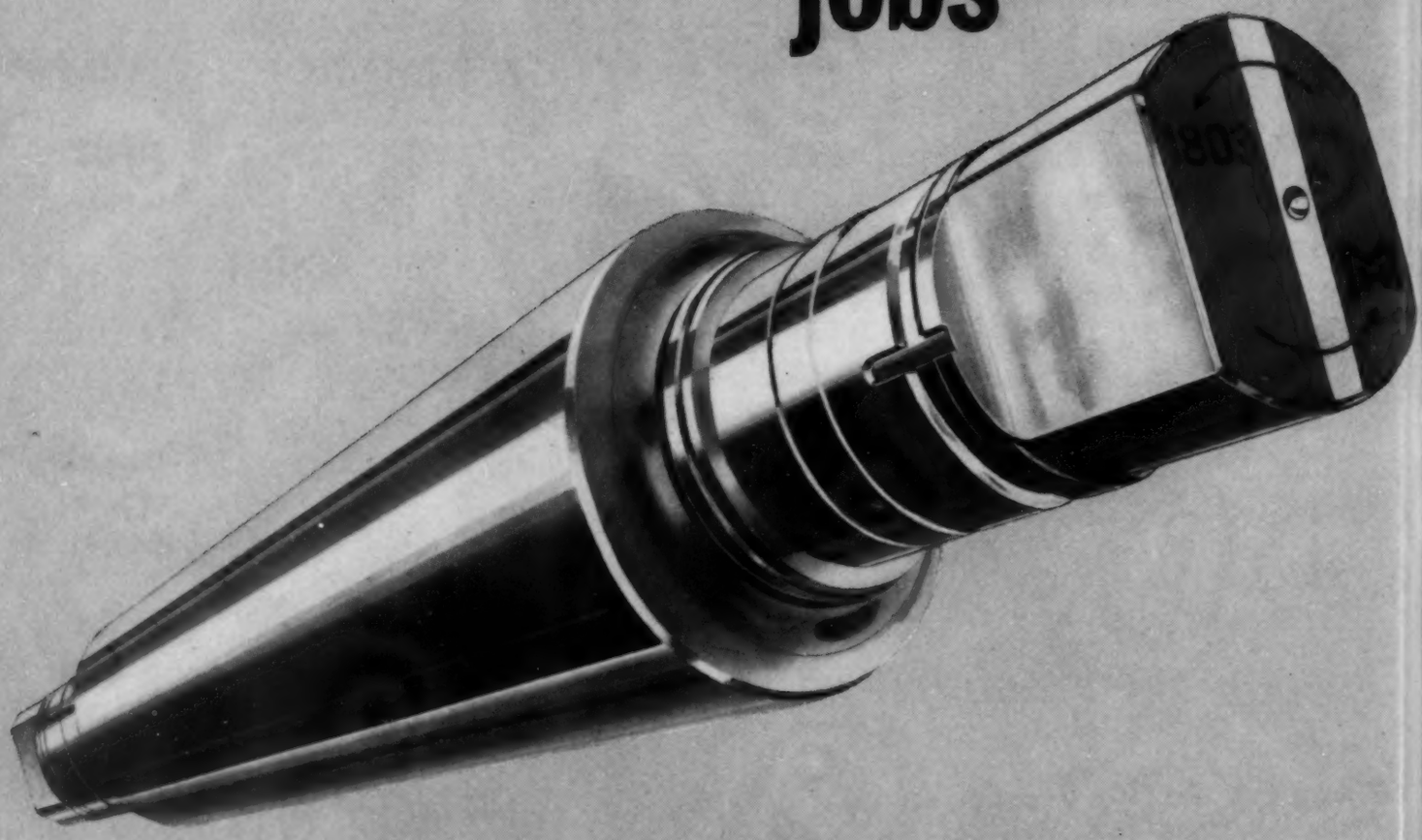

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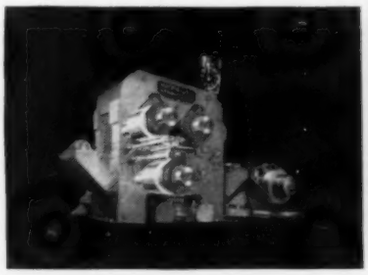

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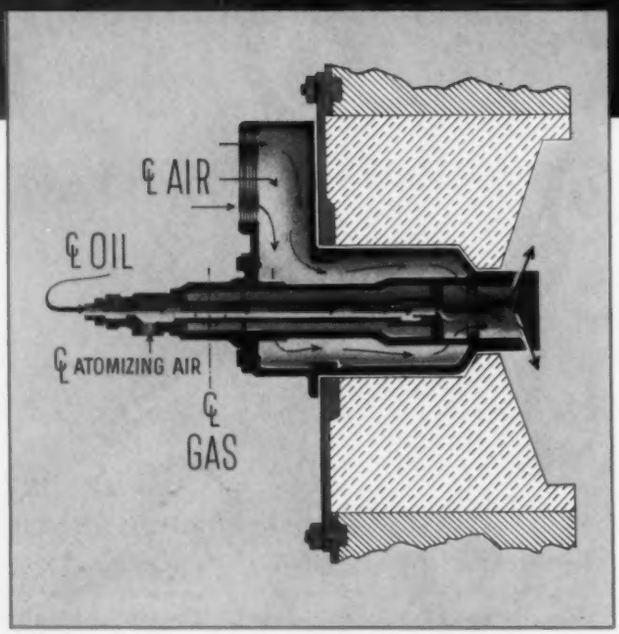

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Faster combustion gives added flexibility to forge plant operations.

- *Light-up time has been reduced to 15 minutes, as opposed to two hours with other types of burners.*

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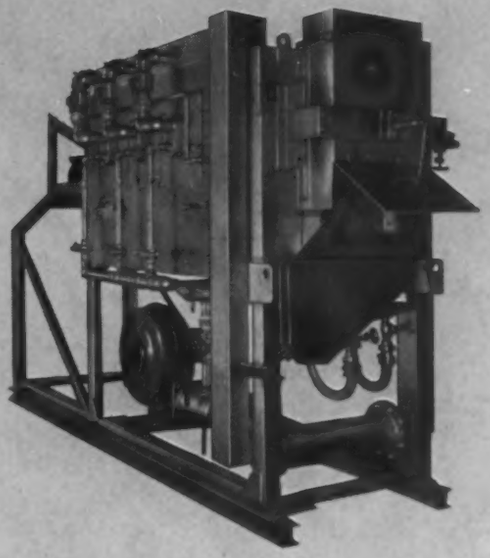

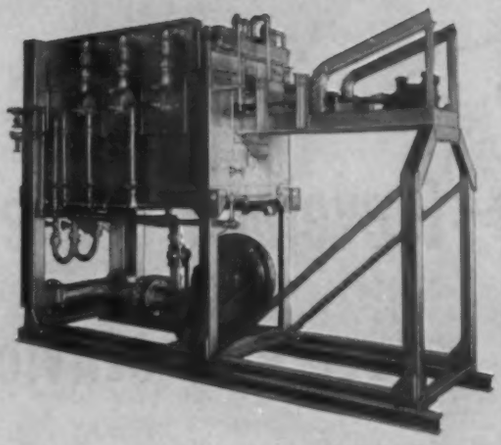

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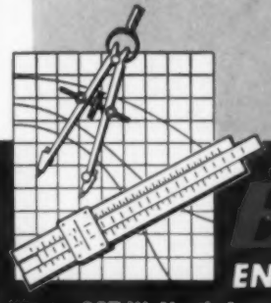
Shown above are two views of a modern automatically-operated forging furnace, equipped with Bloom HTR Burners.

In one mid-western forging plant, twelve similar furnaces employing Bloom HTR Burners have been operated continuously for 18 months without furnace or burner maintenance.



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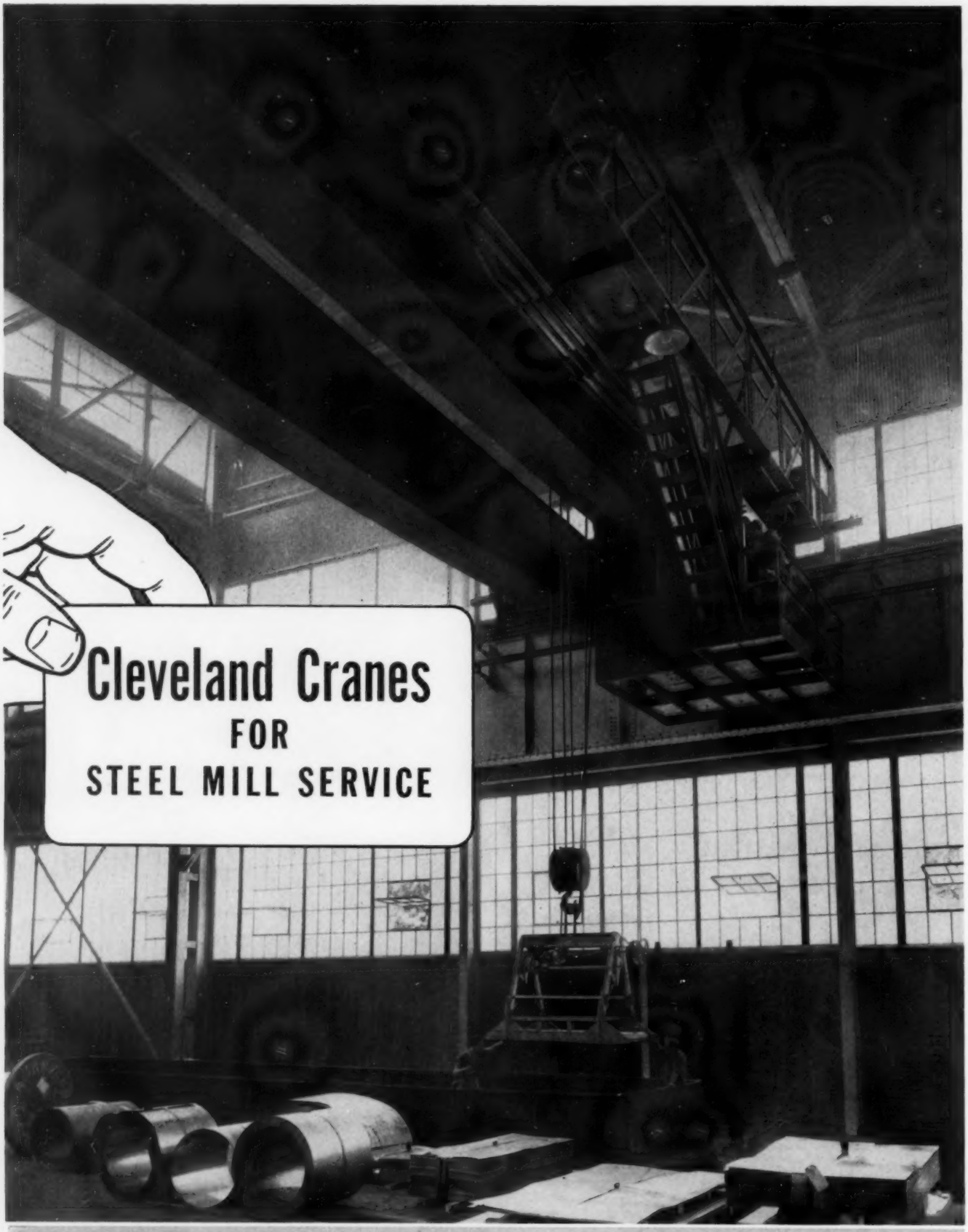

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Crops *and* Shorts

JUST 40 years ago, the Association of Iron and Steel Electrical Engineers, in connection with its regular convention in Milwaukee, scheduled the "First Cooperative Safety Congress." At this meeting, the group requested Association president Barton Shover to appoint a committee to organize a permanent body for the promotion of safety in industry. Thus was born The National Safety Council, which will celebrate its 40th anniversary in October.

The Association of Iron and Steel Engineers is proud of its part in this work, and extends birthday greetings and congratulations to the Council for its fine accomplishments.

▲

WE notice that candidate Adlai Stevenson recommends banning the labor injunction process for halting strikes, and also giving the president the authority to seize business in case of national emergency. Maybe this is his way of showing his "middle-of-the-road" course. Maybe the kind of sauce depends on the number of the geese. We wonder if he's overlooking the fact that United States Steel Corp., for example, has almost as many stockholders as it has employees.

▲

AND on the other side of the fence, Congressman Ralph W. Gwinn of New York introduced joint resolution 491, calling for a constitutional amendment which would prohibit the government of the United States to engage "in any business, professional, commercial or industrial enterprise in competition with its citizens except as specified in the Constitution." The resolution gives a period of three years for liquidation of such activities by sale to private or municipal organizations.

▲

MOST of us know how to say nothing, but few know when.

▲

THE scramble is really on for steel, particularly for cold drawn bar stock and, of course, flat rolled products. Conversion deals are frequent, but some steel users having ingots encounter difficulties in getting them processed.

▲

A correspondent tells us that a man who is so busy that he doesn't have time to read his professional or business magazine is like a man who is so busy chopping wood he doesn't have time to sharpen his axe.

ONCE upon a time it was a common belief that the way to get along in this world was to work conscientiously and to spend less than you earned. Such principles, however, seem to have gone the way of last winter's snow, aided and abetted by our federal administration. No longer is it necessary to work hard to get more money; you merely build up seniority and the better job is yours. No longer is it essential to save money for the rainy day; the government will take care of you. Meanwhile, the government goes merrily on its way with deficit financing.

Following the example of the federal government, more than one-half of our states are also operating with annual deficits, and many municipalities are in the same boat. Now comes a report that the average family spent $400 more than it earned last year.

Well, as someone recently observed, we've never had it so good before taxes. It's a beautiful merry-go-round, spinning faster and faster. And the longer and faster it goes, the dizzier we'll be. There's a hang-over coming, that's for sure. Let's hope it won't be too serious.

▲

OF course it doesn't apply to our staff, but a friend of ours says that a stenographer is a girl you pay while teaching her to type while she is waiting to get married.

▲

MARSHALL Plan funds of about $220,000,000 have paid some 25 per cent of the cost of 31 iron and steel projects abroad, principally finishing plants.

▲

A statement made by DiCyan and Brown, consulting chemists in New York, says that much of the advertising directed to technical men lacks factual information and overlooks description of the product, how it works, etc. The report states that unrelated matters, exaggerations, emotional appeals can even unsell scientist buyers.

▲

A patent has been issued on a process said to convert 80 per cent of the energy in coal into electricity, instead of the usual 30-35 per cent. The process eliminates the turbine and generator. Carbon in the coal is heated in contact with steam, and the resulting gas is piped into a fuel cell. An electrode in this cell yields oxygen to the gas and regains oxygen from an adjacent electrode, which in turn regains oxygen from an air intake. Movement of the oxygen atoms produces electric current which is drawn from terminals. Hot exhaust gases are used to generate steam for the gasification chamber. The economics of the process have yet to be explored.

▲

JUST by way of reminder, don't forget to vote and get everybody else to vote — and plug for your candidate.

▲

AND another reminder: Don't fail to come to Cleveland September 30, October 1, 2 and 3 for the AISE annual convention and exposition — bigger and better than ever.

How to save 300,000 pounds of *molybdenum* and 1,000,000 pounds of *manganese*

Molybdenum is now very scarce, and manganese is far from plentiful. So users of these materials, especially, will be glad to hear that our Spang-Chalfant Division in the past four years has been able to save thousands of pounds of essential resources. The savings were made by heat treating carbon steel casing to give it high strength characteristics similar to those of alloy steel casing.

Since September, 1947, our Spang-Chalfant Division produced over 5½ million feet of high strength pipe by this process. But more important than past production may be our development's effect on future supplies of casing. Even if all molybdenum is restricted from oil field use, we will be able to produce up to 3,500 tons of high strength casing per month without it.

Research in the fields in which National Supply operates requires a great expenditure of time and money. When it pays off for our customers and for the nation as it has in the heat-treating of pipe, we consider it an excellent investment.

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High strength casing, used in deep oil wells, usually is made of alloy steel containing molybdenum and manganese. Many years ago our engineers tested the idea of making it out of ordinary carbon steel, then heat treating it to give it the required ductility and strength characteristics. The difficult problem was to hold the shape of the pipe during heat treating . . . and about five years ago we learned how.

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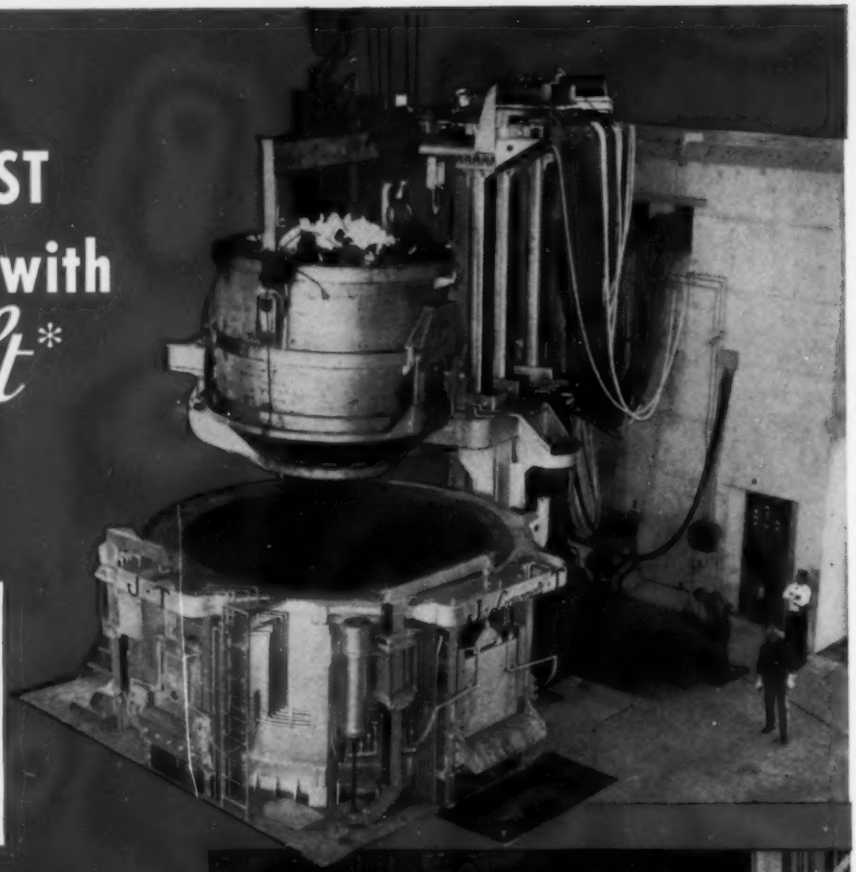
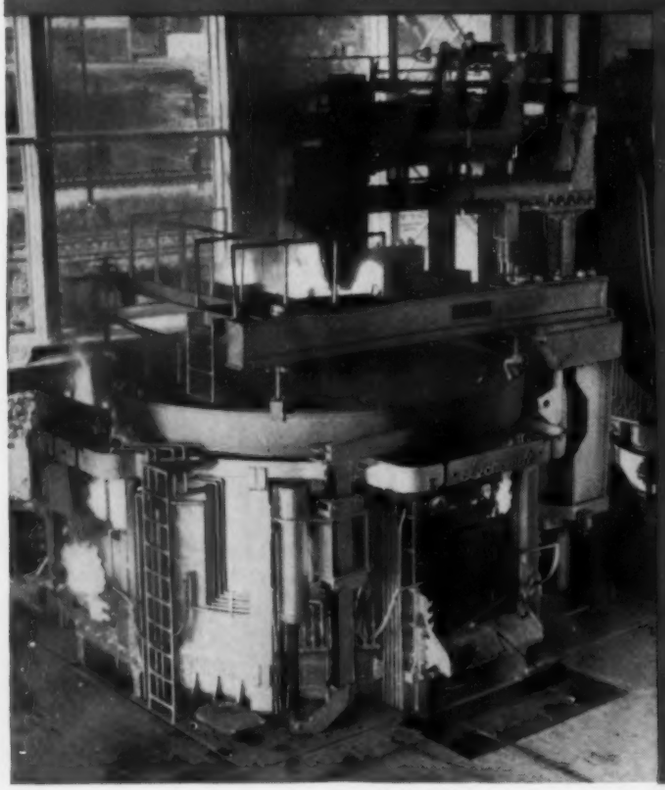
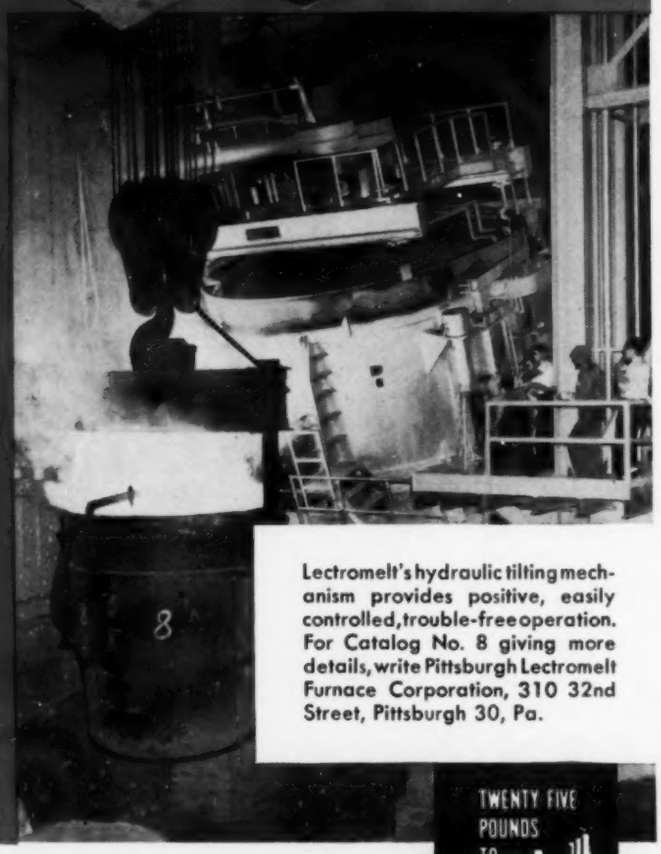


Right: Labor-saving top charging lets a Lectromelt Furnace get to work *fast*.

Below: With a Lectromelt Furnace, you can crowd on the power while holding close control on quality.





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WHEN YOU MELT... MOORE RAPID *Lectromelt*

*Reg. T. M.

METALLURGICAL TIPS
FOR THE MAINTENANCE MAN

By M. V. HERASIMCHUK
Maintenance Metallurgist
Bethlehem Steel Co.
Bethlehem, Pa.

. . . . the maintenance man who applies fundamental principles to the analysis of failures can markedly reduce failures of steel plant equipment . . . .

▲ FUNDAMENTALS of equipment failures have been published in many fine papers and have been directed, for the main part, to design engineers and metallurgists. Several authors have pointed out how equipment failures affect maintenance programs, but few papers have stressed the important part the maintenance man can play in a failure research program.

When mill equipment is being designed and built, the maintenance man is seldom made familiar with the design calculations and the metallurgical features; however, when failure strikes, he is the first to be consulted, because he supervises repair and replacement. This first consultation should be a summary of important facts that the maintenance man can provide; these facts must eventually be collected by the designer or metallurgist investigating the failure. Failure research is more effective if carried out as a three-way project between designers, metallurgists and maintenance men. The purpose of this paper is to present a few simple tips or clues that will help to guide the maintenance man in the collection of the right kind of information for interpreting a failure and to train him to identify the most important contributory factors.

Design, material and loads are the three factors involved in any failure. Loads will not be considered because it will be assumed that the job being done by the equipment is reasonable. Confining the discussion to design and material makes it possible to give examples that will cover a large majority of steel mill problems.

Both design and material can be involved in the two basic failures that we shall call "immediate" and "progressive." Most maintenance men will recognize "immediate" type of failure, but to help them recognize some of the common progressive fatigue failures, four varieties will be shown. In order, the illustrations show fatigue failures that are the effect of—

1. Design only (2 cases).
2. Design aggravated by metallurgical factors.
3. Metallurgical factors only.
4. Metallurgical factors aggravated by design.

The "tips" that are included in this paper were developed in a failure research program and have been used by the author in demonstrations before supervisory and engineering personnel at the Bethlehem plant of Bethlehem Steel Co. In simplifying the problems for such demonstrations, the author has restricted many details to the point of oversimplification. For the research man, this may be a serious omission, but the author's intention is not to make maintenance men independent analysts, but to help them be better informed and better prepared to discuss equipment failures with engineering and metallurgical personnel.

MEASURE THE LOCATION OF FAILURE

The philosophy underlying the instructions to be set forth was stated by Lord Kelvin toward the close of the 19th century: "When you can measure what you are speaking about and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is a meager and unsatisfactory kind." This statement is a neat summary of the first job of the maintenance man or the person conducting a failure research program. Measure the location of the failure from any convenient reference point. As soon as the measurement is recorded, it becomes valuable data. It

is surprising how often the only information that is relayed is, "The shaft broke" or "The gear broke." This type of information breeds indecision.

When a maintenance man learns to record the exact location of failure, he will find that as failures recur, certain features of the measurements will become apparent; the figures either stay constant within a half inch or so, or they vary according to some regular pattern. These characteristics of the figures provide two important tips:

1. When measurements stay constant, say, within a half inch, review the design or operating setup.
2. When the measurements vary, review the metallurgy of the part. In a surprising number of cases, the necessary corrective measures will be forecast by these tips. Illustrations and exceptions to these simple rules will be given later.

IS THE FAILURE IMMEDIATE OR PROGRESSIVE

Having learned the numerical facts associated with a failure, the maintenance man must next decide whether the failure was "immediate" or "progressive." This sub-division is made because these are the two basic types of equipment failures that occur in the normal course of steel mill operations. Visual inspection is usually all that is required to classify the type of failure. "Immediate" failures are characterized by spread, elongation or change in shape or clean crystalline fractures. "Progressive" failures are the fatigue-type that are recognized by the concentric rings, or "beach" marks surrounding a crystalline structure that was last to fail.

"Immediate" and "progressive" failures are summarized by the well-known stress-strain curve and the S-N curve. To show the marked difference in behavior predicted by these two curves, refer to Figure 1.

Both curves represent the strength of heat-treated 41-40 steel. On the left is the familiar pattern of stress versus strain produced when a tensile-test specimen is pulled to its breaking point. All engineers will recognize the yield point and the ultimate or tensile strength. On the right is the S-N curve that determines endurance limit or fatigue strength, and while not so popular as the stress-strain curve, it represents steel mill equipment in action more accurately than any other basic principle. It is clear that under ideal test conditions, 41-40 steel can be broken at 75,000 psi although the stress-strain curve says its tensile strength is 150,000 psi. Even more impressive is the fact that a circumferential 60 degree nick on these fatigue specimens will cause them to break under 30,000 psi load. The underlying reason for this alarming drop is stress concentration, a factor that has not gained sufficient respect because of its text book flavor.

In service, an "immediate" failure such as the bending of a shaft, or the sudden failure of a set of tongs, is the result of violation of the laws behind the stress-strain curve. One load application can exceed the yield point or tensile strength and cause instant spread or failure. A "progressive" failure such as the fatigue failure of an armature shaft, piston rod, or a chisel behaves according to the laws behind the S-N curve. It shows that a part will break at a load far below the tensile strength provided the stress is repeated many times.

This very brief review of the fundamentals of the two arbitrary types of failures serves as a starting point to demonstrate how the maintenance man may recognize them in the field.

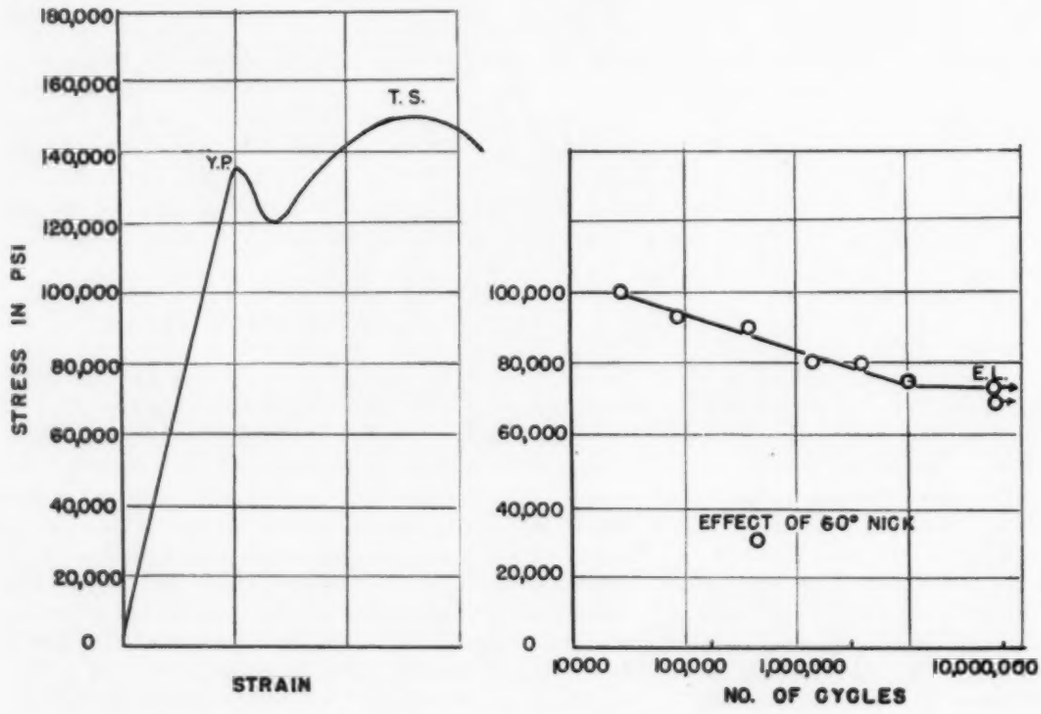


Figure 1 — A comparison of the "breaking strength" of heat treated 4140 steel as determined by the stress-strain curve (left) and the S-N curve (right).

Figure 2 — These high strength alloy steel tongs are used for stripping big-end-up moulds.

IMMEDIATE FAILURE

An "immediate" failure on vital equipment is identified by spread, deformation or sudden breakage under a single load or a succession of heavy but normal operating loads. In all cases, the load exceeds the strength of the material. This type of failure is in the minority, yet is responsible for high maintenance costs in isolated cases. For example, Figure 2 shows a set of tongs used for stripping big-end-up ingot moulds.

Steel mill men will recognize this critical equipment and they know that the tongs on the sides will grip a hot-topped ingot and pull upward while the flapper tongs in the center will push downward on the ingot mould. When these tongs are made of 0.20 to 0.40 per cent carbon steel, cast or forged, the tremendous push-pull action that has to be exerted when "sticker" ingots have to be released, is sufficient to cause the tongs to yield, or even break. In normal operation, nine months was the expected life of a set of carbon steel tongs; in that time they would spread about 9 in., spud holes and pin holes would elongate, thus making it impossible to grip small ingots, and the tongs would have to be replaced.

An alert maintenance man reported this rate of spread to the metallurgical department. In a combined session of design engineers and metallurgists it was agreed that a radical change had to be made in the physical properties of the tong material. Heat-treated 43-40 alloy steel or its equivalent at 150,000 psi yield strength was prescribed; with these properties, alloy steel tongs are now sufficiently strong to resist the opposing forces of any "sticker" ingot. Figure 3 shows a set of tongs after nine months' service.

It is clear that little or no deformation took place on the high-strength tongs. The profile of an identical set of carbon steel tongs after the same service is sketched on the photograph.

Figure 3 — Profile of high strength alloy steel tongs after 9 months service is compared with profile of carbon steel tongs after same length of service (dotted line).

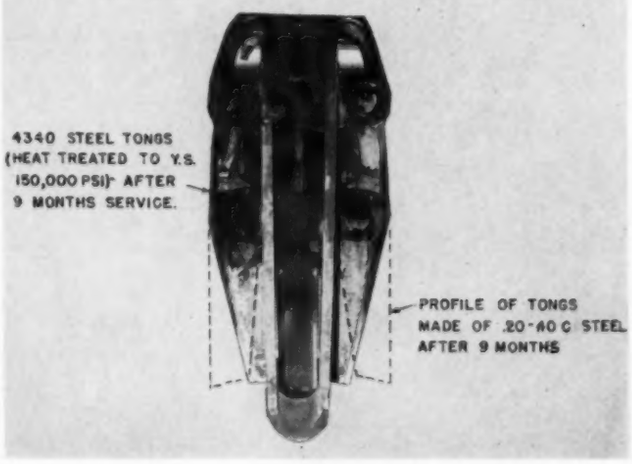


Figure 4 — Broken axle was removed from cinder car used for hauling blast furnace slag. Design shown on the left was responsible for progressive fatigue failure.

Let us look back to see how this example fits the simple rules laid down earlier. First, the measurement taken was the spread between the tongs. The average deformation was nine inches in nine months. This indicated that immediate failure in the form of spread was occurring in normal operation. In addition, it was recorded that sudden breakages occurred at widely spread locations. According to Tip No. 2, this indicates a metallurgical problem and obviously this was the proper approach to the solution.

PROGRESSIVE FAILURES

Immediate failures are easy to spot and correct; progressive failures are more difficult to analyze. "Normal" progressive fatigue failures occur at given locations for specific engineering and/or metallurgical rea-

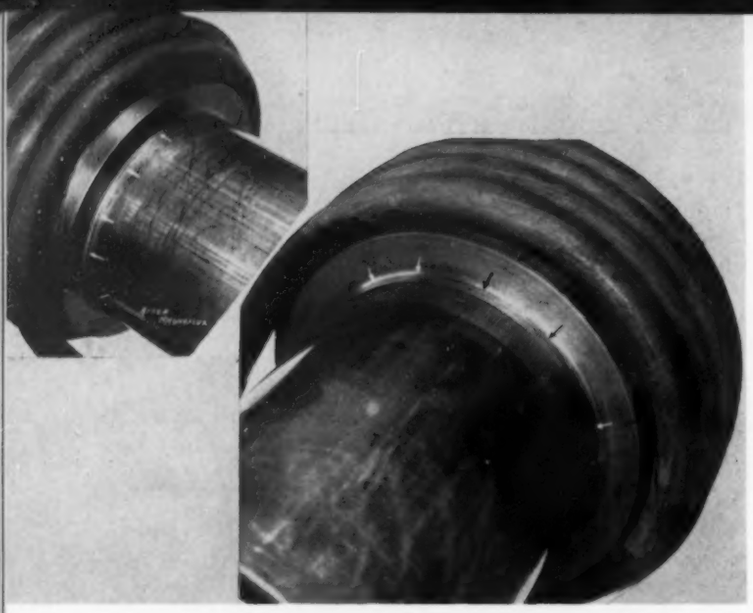


Figure 5 — Closeups of two "unbroken" cinder car axles after magnaflux inspection. Cracks (arrows) are caused by stress concentration in inadequate radii

sons, but the difficulty lies in explaining and proving what conditions have brought about failure. Both explanation and proof will be attempted in the following case histories:

Axle failures on blast furnace rolling stock are a prohibitive expense. At the Bethlehem plant, at least six failures occurred on cinder cars in one year (Figure 4).

When this problem was investigated, it was learned that all failures occurred in the ⅛ in. radius at the end of the journal for roller bearing. All failures occurred at locations that were within ¼ in. of each other. Immediately, in accordance with Tip No. 1, the design was questioned and reviewed with the engineering department. Stress concentration factors were computed and found to be approximately 1.8. This meant that operating stresses were amplified nearly 2 times in the inadequate radius, thus bringing about failure in as early as five months. The design was modified so that a 1¼ in. radius could be used, and as a result there are now scores of axles which have been in service over 25 months without any incidents.

For the benefit of maintenance men who like further proof that this so-called stress concentration is promoting progressive failure, we show the other end of the axles. These were not broken off, but it was reasoned that since the design was the same and loads identical, the axles should be cracked in the radii, if the theory is correct (Figure 5). To the naked eye, there were no visible cracks in the "unbroken" journals, but when an ordinary welding lead magnetized the axle, magnetized particles immediately showed up the cracks and gave the kind of proof every maintenance man understands.

At this point, it is appropriate to point out that the same steel is being used in the modified axle and, therefore, the same S-N curve applies. What does not apply in the modified axle is the stress concentration of the earlier design. Apparently, this type of failure is not "in the steel" and this example is good evidence that many similar shafting problems can be corrected with simple changes that eliminate stress concentration.

To fix this textbook term of stress concentration in the minds of maintenance men, we always review a second demonstration that usually helps make it stick (Figure 6).

Here is the problem: In our ingot mould foundry, a hexagon-shank chisel of all sizes is used to remove fins and flash from castings. For several months, a chronic problem of shank failures that, at times, reach-

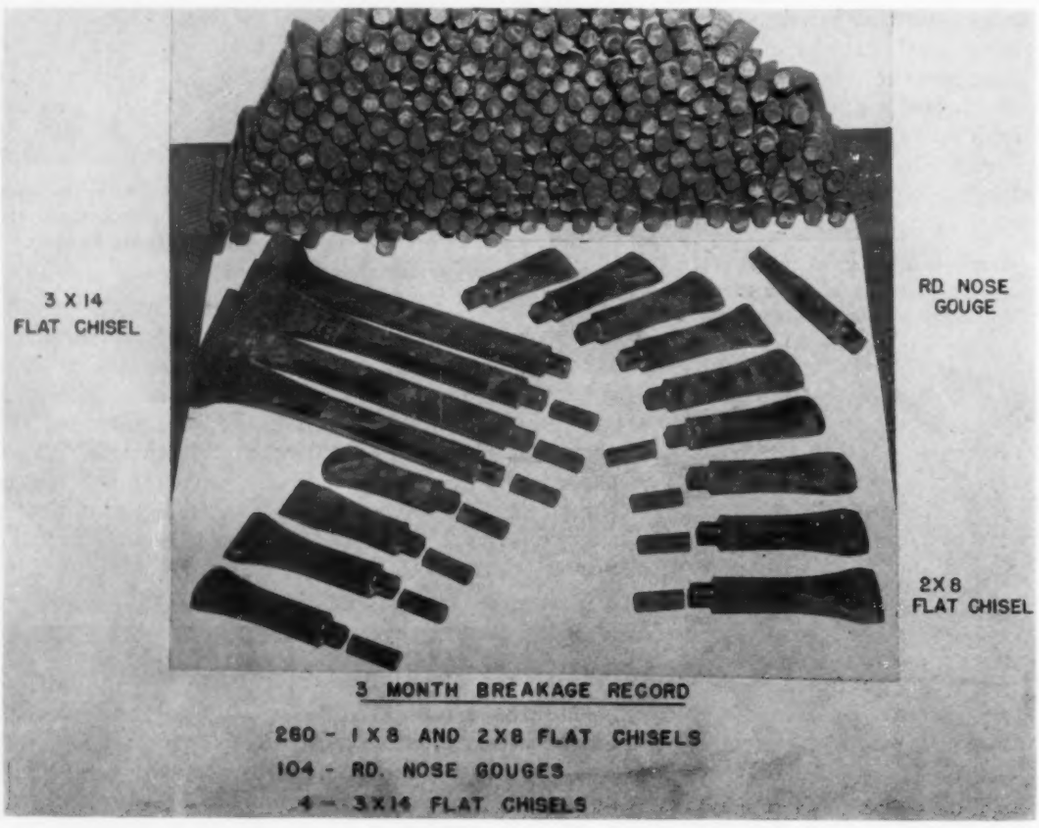


Figure 6 — Shank failures on pneumatic chisels are good illustrations of progressive fatigue failures due to design factors.

ed as high as 30 per cent was experienced. There were three schools of thought on this problem. Some said that a tough job had to be done, so they believed that they should expect breakage; the second school said that worn bushings in the pneumatic guns were allowing too much play and causing undue bending; the third school disregarded both theories and claimed that a chisel should be made to withstand both conditions and the chief reason for failure was stress concentration at the end of the milled hexagon on the shank.

To prove this, and this appeals to maintenance men, a replacement order for chisels was intercepted just before shipment. It was divided into two parts; one-half to represent the product ready for use, the other half was returned to remove the stress raisers at the end of the hexagon. In addition to removing the stress raisers, the section was deliberately cut undersize to dramatize the effect. To the man in the shop, it looked like the wrong approach because the chisel looked weaker instead of stronger. When the tests were finished (Figure 7), the case was won for stress concentration, for in spite of worn bushings or job severity, not one modified chisel broke while 28 per cent of the "regular" product failed the first time in service.

As Figure 7 shows, the principal cause for failure was stress concentration in the inadequate radius or angle produced by improperly ground milling cutters. Note also, that all the failures on the regular product occurred within ⅛ in. of each other; Tip No. 1 reminds us that under these conditions we should review the design, in this case, the machined contours.

The two preceding illustrations are clear-cut cases of progressive failures related to design factors only. Sometimes progressive failures are the result of a combination of design and metallurgical factors and the problem is to decide which is responsible. This type can be illustrated by Figure 8 that shows two sizes of mill motors which failed at what appeared to be inadequate fillets and therefore should be governed by Tip No. 1. However, a careful inspection of the fractures gives an important clue. Figure 9 shows a ragged edge on an otherwise smooth fatigue failure.

Figure 7 — Improperly ground milling cutters produce stress raisers that shorten chisel life. Upper group represents tools made without due regard to stress concentration. Lower group of chisels were made with a deliberate under-cut to show that size is not so significant as stress concentration.

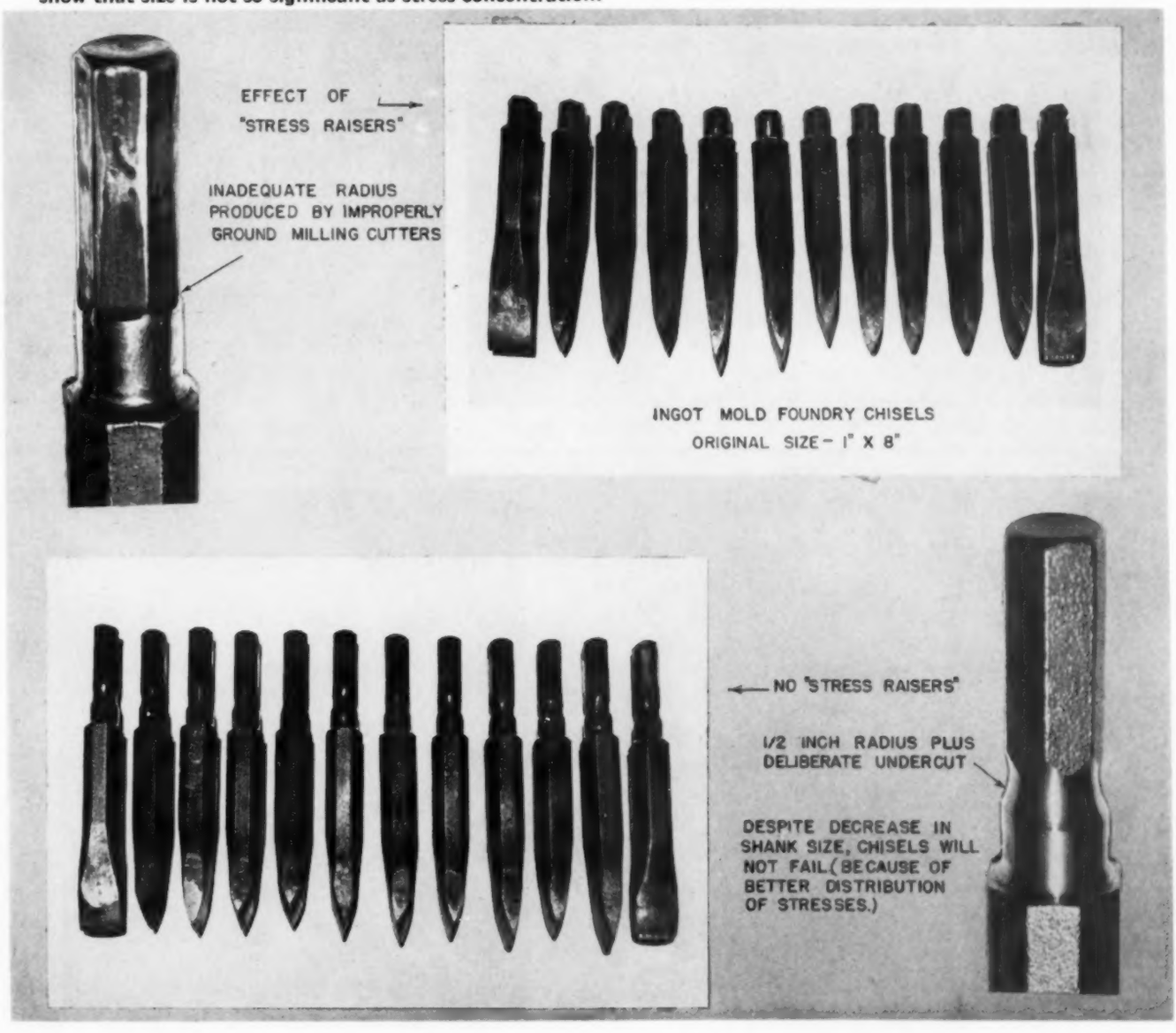


Figure 8 — Heavy duty mill motors with broken armature shafts. Both shafts had been welded to reclaim worn bearing surfaces.

Ragged edges give away the fact that a shaft has been welded, in this case, to reclaim a worn journal. The reason for the ragged edge is shown at the right of Figure 9. Steel men will recognize the weld, the affected zone and the core. In this case, the ragged edge was associated with the sub-surface cracks in the affected zone. Sub-surface cracking extended over the entire length of the journal, but failure was accelerated at the change in section on the shaft where the maximum stress concentration occurs. Since the shaft apparently withstood service with the original design long enough to wear out the journals so that they had to be reclaimed, the blame for the failure lies in the welding technique and, therefore, is primarily a metallurgical failure at the point of maximum stress concentration.

Figure 10 illustrates a case where a metallurgical factor is solely responsible for progressive fatigue failure.

On the left is a pinion shaft taken from a high-powered lathe used for turning heavy forgings. Three teeth are torn out; the manner in which they are ripped out is the clue to the cause. In the author's experience, every instance of this type failure on heavy steel mill equipment was on a torch-hardened product. The combination of very short service and concavity at the root of the teeth reflect improper heat treatment specifications for a gear in heavy-duty service.

Analysis of this problem according to the suggested method shows that failures occur at the same place on each tooth. However, they are widely spaced. According to Tip No. 2, a metallurgical review is in order. There is more than one answer to this problem, the simplest but more expensive is to carburize the pinion. The metallurgical difference between carburizing and torch hardening is shown in Figure 11. The load carrying ability of a carburized pinion may be as much as 100 per cent greater due to the higher strength of the

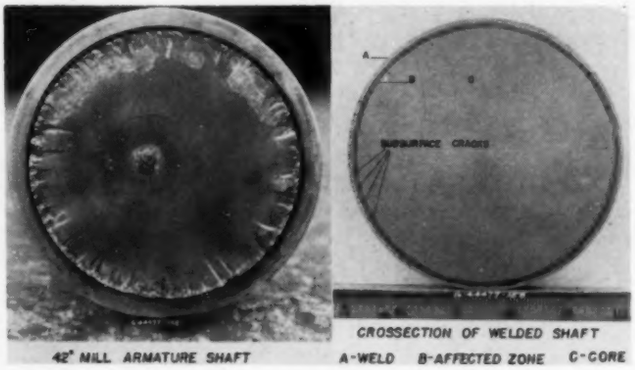
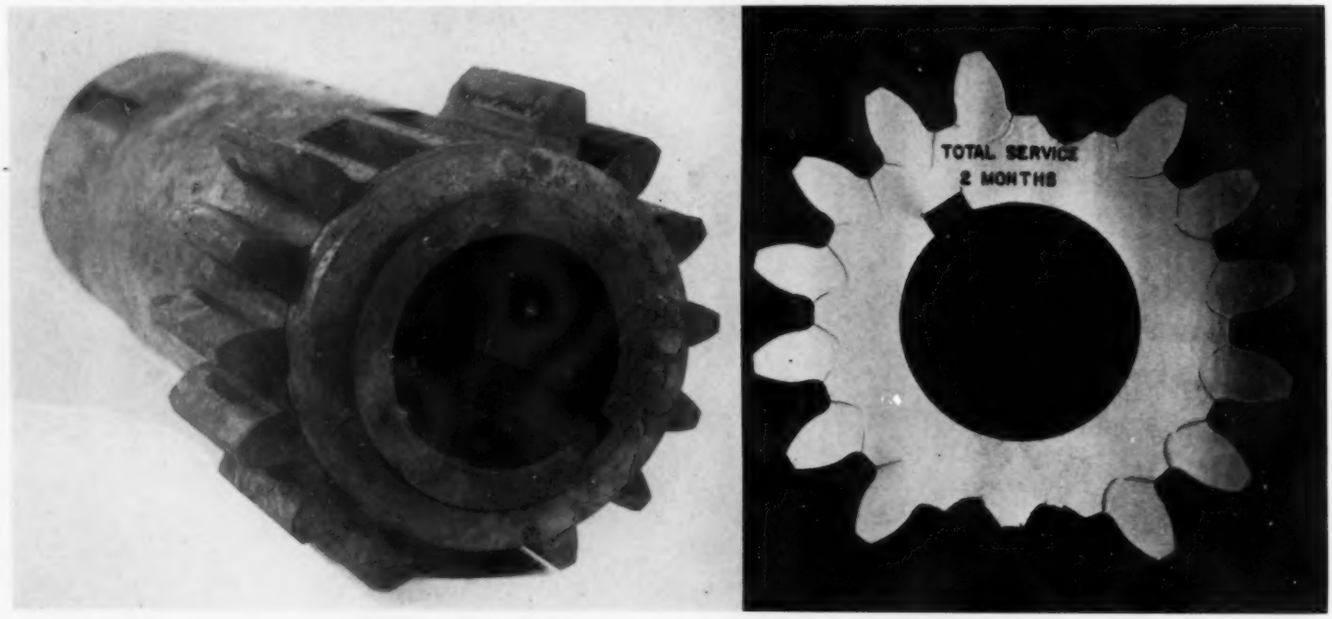


Figure 9 — Characteristic appearance of fatigue failure originating in a weld. The rough, ragged edges were caused by sub-surface cracks that were produced by improper welding technique.

root of the carburized tooth. In lathes or transmissions where high speeds and heavy loads are transmitted, the endurance limit of the unhardened portion of torch-hardened pinions is too low to give good performance.

This opinion does not discredit torch-hardening for

Figure 10 — Pinion shaft with "broken" teeth was removed from a heavy duty lathe after two months service. Cross-section of the shaft shows that fatigue failures were progressing at the root of all the torch hardened teeth.



all gears; there are many applications where this method of hardening is appropriate and it remains for the gear designer to specify the limitations.

Previously, we reviewed one type of chisel failure as a case of progressive fatigue failure that could be attributed to design factors only. Another type of chisel failure can be used to show a progressive fatigue failure that is attributed to metallurgical reasons and aggravated by design. This case will also support Tip No. 2 and effectively illustrate Lord Kelvin's philosophy.

Pneumatic chisel failures are serious not only because they are costly, but because they endanger the

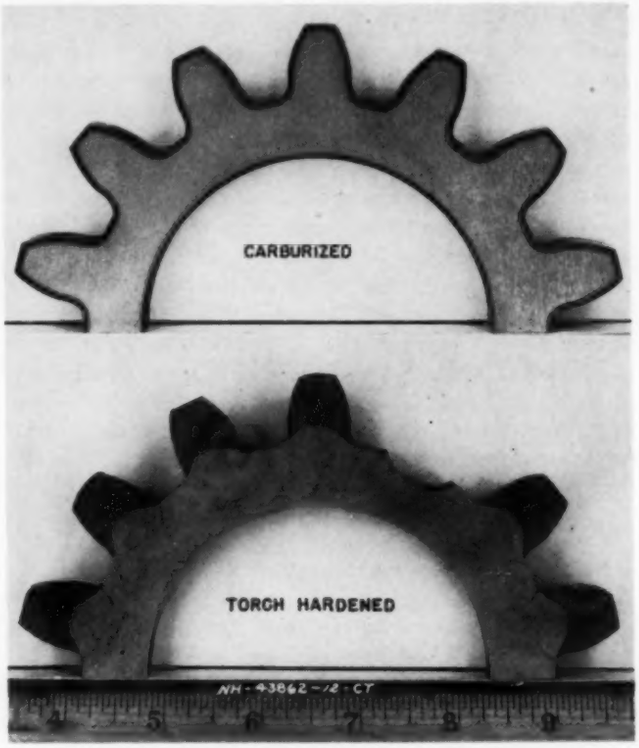


Figure 11 — The high strength root of a carburized tooth resists stress concentrations that occur in all gears in heavy duty service. The carburized surface (dark) has an endurance limit many times higher than the differentially torch hardened teeth (lower).

safety of the man using the gun. At the Bethlehem plant we have gone so far as to call every chisel failure a potential accident and have campaigned against them. Figure 12 illustrates a pile of such potential accidents; these are descaling chisels that originally were 9 in. long.

In service, they were failing progressively at different points and not until we applied Lord Kelvin's philosophy did we get a clear picture of what was happening. A group of 360 fatigue failures was measured and plotted as a frequency distribution (Figure 13). Immediately it became clear that failures were confined to a 2½ in. portion of the chisel and the average length of broken chisel was about 7½ in. This frequently distribution gives certain clues to the failures. The position of the curve tells where to concentrate attention; 95 per cent of the failures occur within 1½ in. of each other. The tailing off to the left and abrupt drop on the right indicate that there are a small number of contributory causes and that the contributions of the causes vary among themselves.

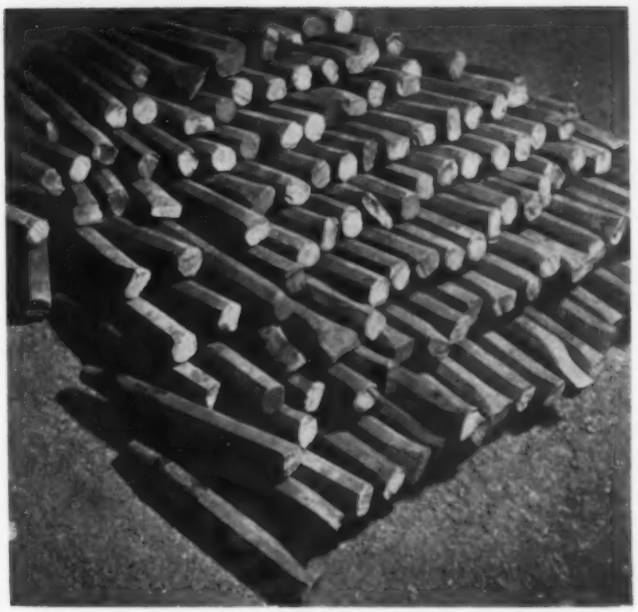
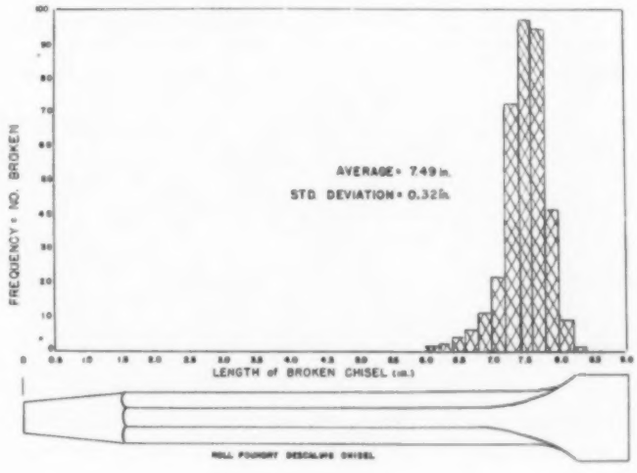


Figure 12 — Descaling chisels after fatigue failure. Originally nine inches long, these chisels fail due to the combined effect of surface decarburization and chisel designs.

Two such causes were suspected: (a) the change in section of the forged taper of the chisel produced a varying distribution of stress, and (b) on each chisel there were varying amounts of decarburization and microscopic surface pits that could lower the endurance limit or act as stress raisers on the chisel.

In keeping with Tip No. 2, the metallurgical factors were considered more serious and the investigation centered on this phase of the problem. How to strengthen the surface layers became the issue, and it was decided that shot peening would produce the desired effect. The effect of peening was so decisive that this practice is now followed for descaling chisels, gouges and similar pneumatic tools with a line of impact off the centerline of the shank. The effect of shot peening on a trial lot of 500 chisels is shown in Figure 14.

Figure 13 — Frequency distribution of lengths of broken descaling chisels. Analyzing maintenance data by statistical methods often clears up nasty problems.



On the first attempt, failures were reduced to 2 per cent; subsequent revision in peening practice reduced failures to less than ½ of 1 per cent and potential accidents to less than 1 in 1000 man-hours of service.

This effect of shot peening does not mean that all pneumatic chisels must be peened to offset the effect of decarburization. There are many kinds of chisels in service with decarburized surfaces which are not failing. If pneumatic chisels do not fail in fatigue along the length of the chisel, peening is wasted effort. In this problem, peening was used to offset the effect of metallurgical factors that were being aggravated by specific chisel design.

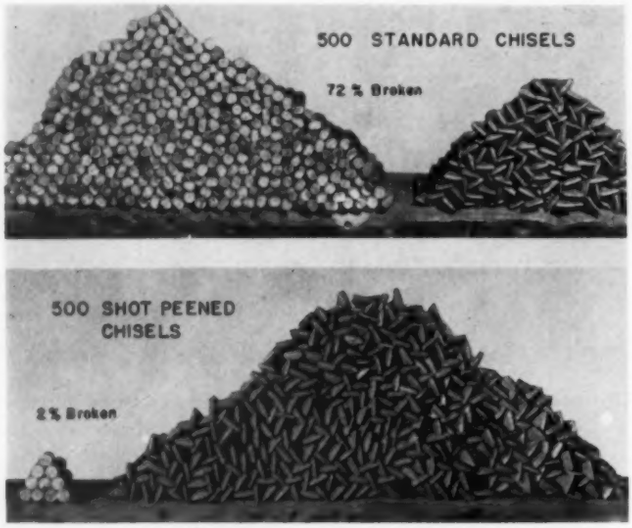


Figure 14 — Fatigue failures that occur on the shank or body of pneumatic tools can often be eliminated by shot peening.

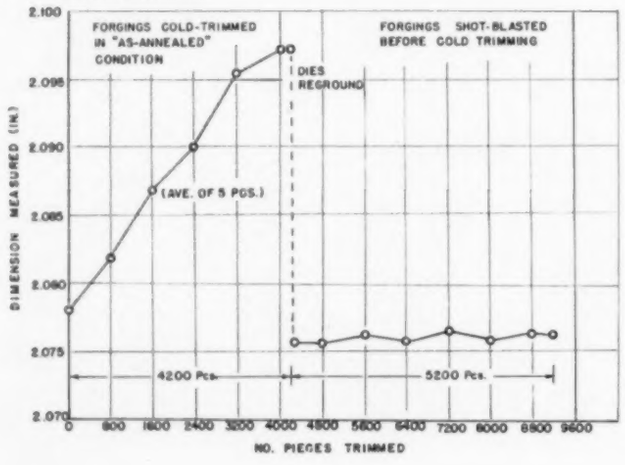
The concluding illustration has been selected to give final emphasis to the importance of systematic measuring and recording significant numbers when studying wear problems. These can be considered as an immediate or a progressive failure involving metallurgical factors. Wear in a steel plant is a constant plague, and the solutions to such problems are as varied as their number. Usually the first approach to an answer is to call for metallurgical advice. This call should be preceded by a simple set of measurements made at timed intervals on the part or product under study. Such data set the stage for development because they provide the facts connected with the problem and later serve as a guide for measuring improvement.

A simple illustration of a practical way of studying such a problem is shown in Figure 15. The initial problem was to prolong the life of trimmer dies made of inexpensive tool steel such as that which is usually applied to short run jobs. Side issues were alloy conservation, less delays, more production.

First, to learn the performance under regular practice, a routine measurement of a dimension on the flash line of the trimmed forging was ordered at the end of each 800 pieces. Five pieces were measured and their average plotted. At the left of Figure 15 are the results of the "normal" performance of the tool steel when trimming "as annealed" forgings. The rate of wear in terms of number of forgings trimmed per grind is about 4000. The cause for this wear was the thin layer of abrasive scale on the forgings. Shot blasting the forgings after annealing removed the scale and the tool performance changed as shown on the right. Apparently the low-cost steel will last indefinitely provided the source of wear is removed.

The point in this case is that the picture of the rate of wear and the picture of the effect of shot blasting have been shown. This kind of evidence is more forceful than words or claims, and gains respect, all in return for a few careful measurements.

Figure 15 — In studying wear problems, the maintenance man can show causes and effects by taking proper measurements.



SUMMARY

In an attempt to guide the maintenance man in collecting better failure information, an effort has been made to present a few basic principles underlying steel mill equipment failures. The several tips and clues that were given are believed to be practical aids in solving such problems. They show that the first job of the maintenance man is to collect pertinent information about the location and type of failure. They show that design factors and metallurgical factors are distinct in their effects, yet often overlap. They also show that relatively minor design or metallurgical changes will produce effective results. The illustrations do not cover every type of failure, but the principles involved in those that are presented, cover a large portion of failures that occur in most steel plants. It is understood that a maintenance man who applies the fundamentals will not immediately become an independent analyst, but he should be able to grasp the method of approach and realize his part in a failure research program that should combine the best efforts of the designer, metallurgist and the maintenance man.

BIBLIOGRAPHY

1. "*Use of Alloy Steels in Iron and Steel Mill Equipment*," by E. R. Johnson and O. A. Bamberger, Transactions of the American Society of Mechanical Engineers, 1929-1930.

2. "*Better Construction and Better Maintenance by the Use of Alloy Steels*," by E. C. Smith, Proceedings of Association of Iron and Steel Electrical Engineers, p. 116, 1932-1934.

3. "*Alloy Steels for Maintenance*," by J. A. Rosa, Proceedings of the Association of Iron and Steel Engineers, 1945.

4. *"A Review of Some Failures of Steel Plant Equipment,"* by S. W. Poole and R. J. Johnson, Proceedings of the Society for Experimental Stress Analysis, Vol. 3, No. 2, 1946.

5. *"Types of Fatigue Failure in the Steel Industry,"* by W. O. Beale, Symposium on the Failure of Metals by Fatigue, Melbourne (Australia) University Press, p. 455, 1946.

6. *"Selection of Engineering Materials for Coke Plants,"* Blast Furnace and Steel Plant, April, 1948.

7. *"Prevention of Mechanical Failures in Steel Plant Equipment,"* by Dr. O. J. Horger and G. A. Stumpf, Proceedings of the Association of Iron and Steel Engineers, 1948.

8. *"Metals in Service,"* by P. M. Hess, Proceedings of the Association of Iron and Steel Engineers, 1948.

9. *"Selecting Materials to Reduce Maintenance,"* by W. H. Sparr, Proceedings of the Association of Iron and Steel Engineers, 1948.

10. *"Practical Metallurgy for the Steel Mill Engineer,"* by W. B. McFerrin, Proceedings of the Association of Iron and Steel Engineers, 1948.

11. *"The Metallurgy of Steel Plant Maintenance,"* by R. E. Crasweller, Proceedings of the Association of Iron and Steel Engineers, 1949.

12. *"Why Machine Parts Fail,"* by Charles Lipson, Machine Design. May-December, 1950.

13. *"Corrosion Problems in the Modern By-Product Coke Plant,"* by C. F. Pogacar and E. A. Tice, Corrosion, March, 1951.

14. *"Preventive Maintenance Procedures,"* by J. B. Whitlock, 1951 Yearbook of the American Iron and Steel Institute.

DISCUSSION

PRESENTED BY

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L. F. COFFIN, Assistant General Manager, Bethlehem Steel Co., Sparrows Point, Baltimore, Md.

M. V. HERASIMCHUK, Maintenance Metallurgist, Bethlehem Steel Co., Bethlehem, Pa.

R. J. Johnson: We have noted the work at Bethlehem with particular interest since it represents further evidence of growth in the application of metallurgical methods to plant maintenance. Endeavors of similar nature are active at Armco, Timken, Great Lakes, Jones and Laughlin, United States Steel and Republic.

Special thanks are due the AISE for its part in encouraging this trend as evidenced by the publication in recent years of several fine papers emphasizing materials and maintenance metallurgy. A list of fourteen references on the subject is given herewith for those who may be interested.

In the Central Alloy District, Republic has recognized the metallurgical phase of maintenance beginning in 1929 when E. R. Johnson and O. A. Bamberger reviewed a paper on "Use of Alloy Steels in Iron and Steel Mill Equipment" before the American Society of Mechanical Engineers. In 1932 E. C. Smith gave a report on "Better Construction and Better Maintenance by the Use of Alloy Steels" at the Association of Iron and Steel Electrical Engineers meeting. More recently J. A. Rosa discussed "Alloy Steels for Maintenance" at the 1944 AISE convention and S. W. Poole and R. J. Johnson presented "A Review of Some Mechanical Failures of Steel Plant Equipment" at a meeting of the Society for Experimental Stress Analysis in 1945. For the last six years this work has been conducted through the Research Department headed by M.J.R. Morris.

Lately we completed an analysis of 263 failures dating back to 1927. In this study the principal causes of failure in the Canton and Massillon plants were determined and present effort is directed toward elimination of these causes.

Improved engineering and shop practice brought about by cooperation of the several departments involved has been much more effective in reducing the number of failures and delays than was the individual failure investigation approach.

Mr. Herasimchuk has indicated that failure research includes not only the analysis of fractures, but the solution as well of difficulties involving wear, heat, corrosion, welding and application of materials. The field is very broad and reflects the whole complex operation of maintaining a modern steel plant.

Good departmental records are a necessity in any maintenance program. However, it is believed that details of the type required by the author may be more the responsibility of investigating personnel rather than the maintenance men whose primary concern is continued operations.

With respect to welding, I should like to mention that we have severe restrictions concerning salvage of armature shafts, gears, axles, lineshafts, table roll journals, etc., by this method. Most of these items are made of alloy steel produced in our plants and we are very much aware of the consequences of indiscriminate welding.

Flame hardening is an accepted method for hardening steel and the practice is growing in some areas. As noted by the author, care should be exercised in the application of flame hardened parts for certain heavily loaded mill equipment. In our experience, best results have been obtained with carburized or through-hardened alloy steel gears.

Regarding the failure of gears by tooth breakage, concavity at the root of the teeth is a function of geometry and stress distribution and has been observed in both statically and dynamically loaded gears regardless of the material or method of treating. The American Gear Manufacturers Association has reviewed the mechanics of gear tooth failure, and further information is to be found in the paper "Stress Distribution in Spur Gear Teeth" by F. H. Boor and E. O. Stitz, Proceeding of the Society for Experimental Stress Analysis, Vol. 3, No. 2, 1946.

Finally, a question arises as to the relative cost of maintaining the trimmer dies, which the author states are made of inexpensive steel, and cost of shot blasting the forgings in order to reduce die wear. Often it is the practice to hot trim the forgings as the last operation off the forge, thus avoiding cold trimming.

J. M. Jeffries: We have, in our plants, metallurgists assigned to general maintenance problems and hold regular monthly meetings attended by representatives of metallurgical, field and shop maintenance, engineer-

ing and operating departments to discuss many of our major problems. As a result, we are usually able to correct many of our problems.

However, we have much room for improvement and I would like to ask Mr. Herasimchuk how they uncover or develop the various problems of the maintenance man—are delays studied and repetitive delays analyzed for correction? Are the foremen contacted on their problems? Are on-the-job inspections made by this maintenance metallurgical research engineer?

Do you use or have you used the supersonic reflectoscope on critical applications such as checking crank pins, ladle crane hoists shafting, etc.?

In your review of these failures, do you consult with or have a representative of the operating department attend discussions on these problems? What per cent, if any, of your failures can be attributed to operating personnel continually increasing loads or exceeding limits without consulting engineering or maintenance departments? Also, have you been able to trace failures to faulty operations or to the operator of this equipment?

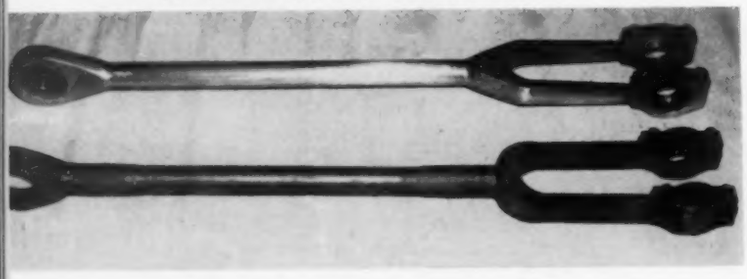
R. I. Swanson: The analysis of an equipment failure with a view of preventing a recurrence is often a difficult job for the maintenance man, engineer, or metallurgist. The approach suggested in this paper is a tool that can be used in many cases. An accurate analysis of the cause for the failure is usually a necessity to applying corrective measures to prevent recurring breakdowns.

A minor criticism of this method for general application might be that on larger breakdowns it is not desirable to wait for repetitions of the failure to build up a case. However, where a number of pieces have failed, the method as demonstrated can apparently be applied with success.

Failure of a tool or machine which results in a halt in operation is serious, whether it involves a small or a large group of men. Most operators and maintenance men recognize this source of mill delay and so are willing to spend a little time and get assistance, if possible, to solve the problem. This type of failure might be designated as an "acute" maintenance problem. It should be dealt with because it is a potential cause of lost production and, possibly too, may be a safety hazard.

Another type of maintenance problem which takes a lot of time on down turns is a sort of "chronic" problem which is often tolerated for surprisingly long periods of time. We might suggest as examples such jobs as weekly packing of hydraulic pumps, changing lineshafts due to worn gears after very short service life, or changing certain bearings at too frequent intervals.

Figure 16 — By modifying design of a connecting rod to eliminate stress raisers, many months of increased continuous service were achieved.



I am wondering whether Mr. Herasimchuk has any suggestions for an approach to or a means of isolating and analyzing this "chronic" type of failure which keeps a lot of maintenance people busy.

J. F. Woschitz: We concur in the necessity for obtaining facts surrounding a failure and the type of service to which the equipment is subjected in order to expedite solution of a difficulty. Directing the thinking of maintenance men along the lines suggested in the paper should result in obtaining the type of information most useful. The tips and clues cited have universal application and should be a distinct help in equipment failure studies.

The author's chisel breakage case study parallels almost exactly the experience with chipping chisels a number of years ago at the Indiana Harbor works of the Inland Steel Co. Two epidemics of chisel breakage were experienced. Causes were found to be an inadequate radius at a shank shoulder in one case, and in the other excessive decarburization at various positions on the chisel. Solution of the problem conformed to the author's tip No. 1 in the first instance where a constant dimension required a larger radius design change, and in the second instance to tip No. 2 where a variable location of failure indicates a metallurgical cause, a change in heat treating practice reduced this type of failure.

Although design engineers generally recognize the injurious effect of notches as stress raisers, shafts with inadequate radii at changes of section and sharp keyways are still encountered. The maintenance man has not much control over an original installation of equipment but he can guard against these conditions in replacements.

Finally, I would like to stress a point which the author has implied and that is the desirability for keeping written file records of equipment failures. Such written records provide a quickly available background of experience and tend to eliminate the effects of personnel changes, reliance on memory, etc. These records would appear to be best kept up by the maintenance department for their own information, as well as to provide a starting point for formal failure investigation.

This paper is timely in this period of increasing alloy shortages when substitute steels instead of the best steels for the job will be used, and the pressure for deliveries invites short cuts in fabricating practices.

L. F. Coffin: Figure 16 illustrates a revision made in method of manufacture of a connecting rod used in flying hot saw on a continuous butt weld pipe mill. The lower rod shows the original design made with a piece of tubing or hollow bored shafting with each end pressed in and welded to the tubing. There were repeated failures until it was replaced with a solid forged rod, shown on top, polished all over, hollow bored with a round nose drill, and then reamed. The object was to eliminate any stress raisers. This connecting rod has given many months of continuous service.

M. V. Herasimchuk: Mr. Johnson's review of the literature on failure research and the questions raised by Mr. Jeffries and Mr. Swanson reflect the trends in the perpetual effort being made to improve performance of steel mill equipment. For the main part, the early studies reported in the literature show why indi-

vidual failures occur and all types are adequately explained. Nowadays the problem has shifted from "Why?" to "How?" and, in general, Mr. Jeffries' and Mr. Swanson's questions are: (1) how do you establish a good working program, and (2) how do you disseminate known and new information so that it is used by the proper persons?

At Bethlehem plant of Bethlehem Steel Co. failure research parallels that at other steel mills, i.e., the Metallurgical Division carries out the programs suggested by the operating and maintenance groups. In some cases, projects are selected from the files of the metallurgical laboratory where reports on individual failures show up a chronic problem. When a project is assigned, the investigation becomes a long range program to gather facts because it is increasingly evident that equipment performance is a statistical function best described by frequency distributions. In most cases, a study of a single failure will reveal the cause, but a study of several failures is necessary to grasp the scope of the problem. The individual failure investigation seldom brings about the unanimity of thought and action that a sizeable group will.

During the fact collecting period of a project all interested persons, often down to operator, are interviewed and made acquainted with the purposes of the project. All standard methods of inspection or laboratory investigation are used to establish facts; to date we have not had occasion to use sonic methods in this type of work.

When facts are assembled, an analysis of the data usually points out the proper approach, i.e., after applying Tip No. 1 or Tip No. 2 a decision is made on what changes shall be made on replacement parts. As the study continues on the modified part, proof or disproof of the modification soon become apparent.

When progress is evident or success imminent, the new information is applied to similar parts or projects and the modification is double checked.

Final reports are the principal means of disseminating the information; however we have held group meetings down to foreman level in engineering department, manufacturing units, and maintenance groups. At these meetings the projects are reviewed from the point of view of the group involved.

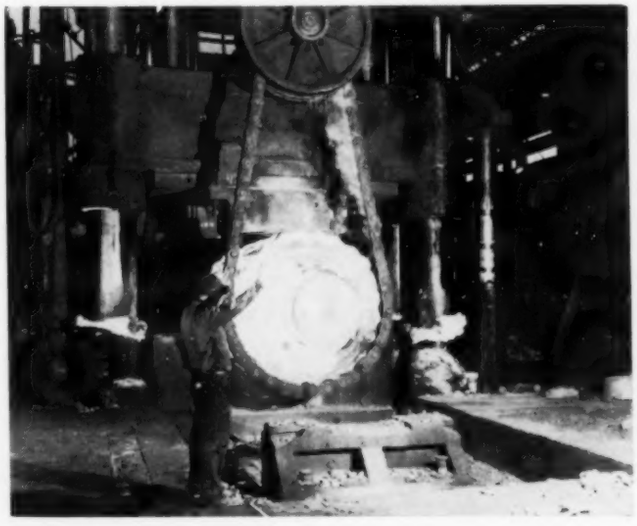
To date we have concentrated on design or metallurgical problems leaving equipment abuses to be corrected by the operating group. It has been our experience that it is better to assume that the human element is the last item to be checked. We operate on the principle that the equipment should be able to withstand "normal abuse" by the workers.

The "chronic" failures mentioned by Mr. Swanson are also neatly summarized by frequency distributions. By this method, the past performance of say, 36 months, will give a complete picture of the problem. The solution depends on the problem.

The author is grateful for the criticisms offered and for the additional information supplied by Mr. Coffin. It appears that his problem is governed by Tip No. 2.

FORGING OF LARGE STEEL DISCS PRESENTS PRODUCTION PROBLEMS

Bethlehem Steel Co. encountered unusual problems in forging some large, alloy steel disc blanks as shown here. Starting with a 92 in. ingot weighing more than 48 tons, final discs 18 ft in diameter and 9 in. thick were produced. Because of the limited distance between the columns of the 7500-ton press, the position of the piece required partial forging of two discs at the same time to avoid unequal loading of the press. The discs, after machining and finishing, will be used in a large compressor being installed in a new supersonic wind tunnel in NACA'S Ames Aeronautical Laboratory. Two compressors, used independently, will operate the tunnel. Either compressor can be connected to the unusual drive, which consists of four 45,000 hp motors, said to be the largest of their kind ever constructed. The combination of 180,000 hp is also said to be the greatest power output ever harnessed to a single shaft.



CRANE RUNWAY MAINTENANCE

By H. R. KNUST
Assistant Superintendent
Mechanical Department
Bethlehem Steel Co.
Sparrows Point, Md.

. . . . with an adequate building organization and a careful inspection program, followed by careful job planning, the difficult work of crane runway maintenance can be successfully accomplished . . . .

▲ CRANES are one of the most important mechanical aids to the material handling and production systems in a steel plant today. As such, most plants are putting increasing emphasis on providing for their regular inspection and maintenance. However, one of their most important counterparts, the crane runway structure, is sometimes overlooked. Normally, in most large steel plants, the inspection and maintenance of the cranes themselves is entrusted to the electrical department, but as for the runways themselves, the responsibility for their maintenance may be assigned to either the electrical or the mechanical department. In either case, it is probable that since the electrical foreman is kept busy with his manifold electrical problems, and the master mechanic is usually involved in the maintenance of his mill proper, the crane runways may become a stepchild that nobody cares for or wants. Too often they are expected to last forever, and as long as the cranes can bump along over them, nobody is likely to worry too much about their condition. This, of course, is wrong, as a poor runway can cause excessive wear on the crane as well as give trouble in operating it, due to the crane or trolley drifting because of improper runway grade. It is the purpose of this paper to suggest how an organization, whether it be mechanical or electrical, can set up a satisfactory system of inspection and maintenance of crane runways, and to discuss some common maintenance problems and what can be done about them.

First, it is imperative that some one person or organization or group be charged with the *specific responsibility* for crane runway maintenance. Second, once this responsibility is fixed, the division charged with this responsibility should see to it that every foot of crane runway in the plant, together with its supporting structure, be *very* carefully inspected at least once a year, and the needed repairs be classified and noted in report form. Third, from these survey reports, they should decide what is to be done and how it is to be done. Fourth, they should schedule when the repairs are to be made and fifth, sometimes the most important, follow the whole program through to completion. Where a plant is of sufficient size to have a separate building maintenance force, the responsibility for proper crane runway maintenance can be a part of the function of this organization. Figure 1 shows a typical page of a survey report and indicates the type of in-

Figure 1 — Repairs on survey report are broken down into Class "A," "B" and "C."

PLATE MILL SLAB YARD CRANE RUNWAY GIRDER

(SOUTH CRANE RUNWAY GIRDER)

CLASS "A"

Crack in the connecting clip at shear bearing connection - column No. 3.

Crack in the web and under the top flange of crane runway girder. Loose rivets and cracked plate in back of column connected to the auxiliery girders - column No. 6.

The following defects were noted at column No. 8 - loose rivets and cracked plate in back of column connected to the auxiliary girders; connecting angles, both in the face of crane runway girder and in back are cracked; rivets are sheared in the bottom flange connected to top of column; loose rivets in the top cover plate, connected to top flange of crane girder; flange of the column above the level of the crane runway girder is distorted.

Connecting angles in the end to end crane runway girder connection and the diaphragm connection in back of crane girder are cracked at columns Nos. 9 and 13.

The full length of the crane runway cover plate under the rail flange is showing much wear. In some places, the plate is worn in two and also showing cracks throughout.

CLASS "B"

Loose rivets in the end to end crane runway girder connections and the stiffener plate connected to the back of column and auxiliary girders at columns Nos. 4 and 5.

CLASS "C"

Column No. 20 above the crane runway level is distorted.

formation that can be assembled by an organization of this kind. Figure 2 shows a typical cost estimate. Figure 3 shows a typical, yearly schedule of repair jobs. Complete and detailed description of how such a force operates, how the jobs are scheduled, followed up, etc., is given in a paper entitled, "Maintenance of Building Structures," presented by R. O. Chapman before the Philadelphia Section of the Association of Iron and Steel Engineers on February 3, 1951, and published in the 1951 Proceedings of the Association of Iron and Steel Engineers, p 852.

The only way to have the complete job of maintaining crane runways done efficiently, once the organization for handling it has been set up and is functioning properly, is to be sure to have enough of the proper materials provided for and carefully to plan and schedule all crafts involved for each job well ahead of time. Many times the work can be fitted in with other repairs in the mills. If you know what you have to do and have your material ready, you can sometimes take advantage of the other fellow's unfortunate breakdown and get your job on the crane runway done at the same time. The policy of most progressive steel plants today is to shut units down when necessary to give a well-organized maintenance department the opportunity to do necessary repairs. If you have the facts to back you up and fight hard enough for it, you will find that this policy also applies to the repairing of crane runways.

There are a few broad general principles concerning crane runway maintenance that should be stated before discussing some maintenance problems in detail. First, runways should be cleaned periodically of dirt, grease, and trash. A clean runway makes inspection easier and repair jobs safer. Almost any of the standard heavy-duty portable vacuum cleaners will pay for

LOCATION - PLATE MILLS

JOB - Structural Repairs to 160" & 110" Mills Furnace Buildings.

Estimate # 325

Charge R-5-A

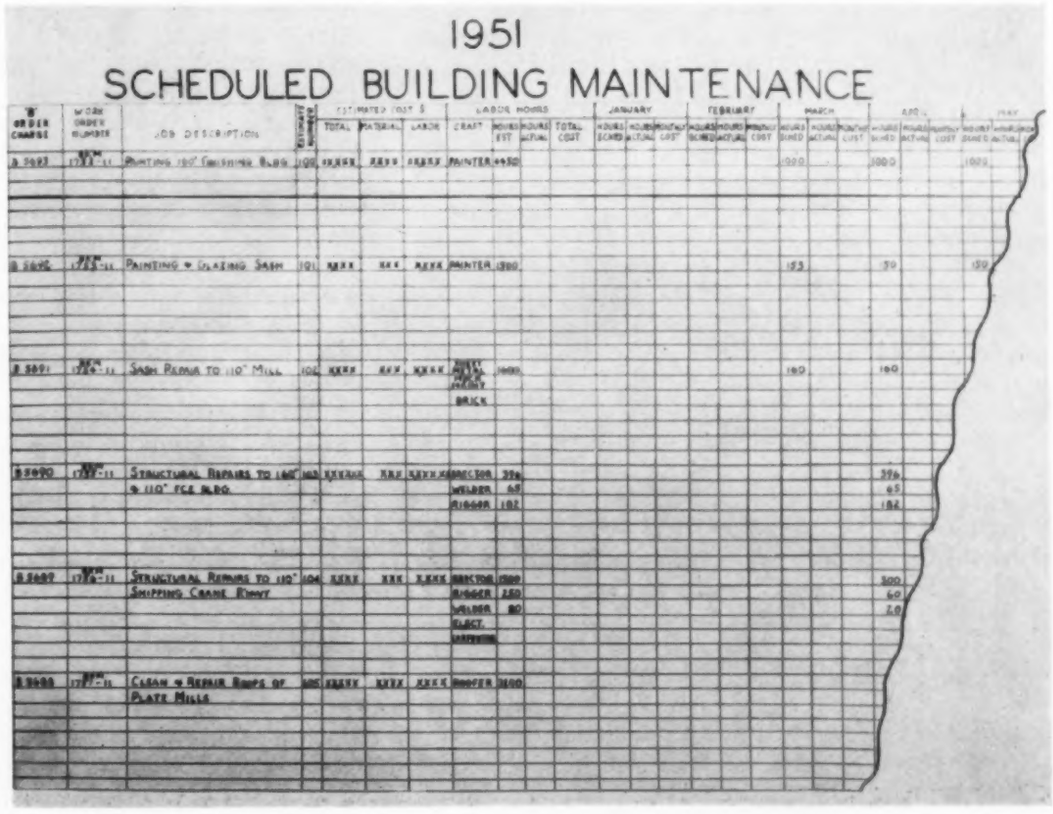
DESCRIPTION	DRAWING NUMBERS	HOURS	QUANTITY	UNIT COST	AMOUNT
Repair bottom chord of lean-to roof trusses at correcting points over furnaces by replacing sheared angles and rivets, and erect a plate bracket from colum to truss at columns #5 and #6 West side and #6 and #7 east side in 160" mill. In the 110" mill the points are at columns #3, #4 and #9 west side and columns #2, #3, #4, #6 and #10 East side.					
Reinforce 24 excessive large holes burnt in the web of the crane girders to allow door cables to pass through.					
Erector		396		$x.xx	$x,xxx.xx
Welders		65		x.xx	xxx.xx
Riggers		182		x.xx	xxx.xx
Materials					xxx.xx
			Total		$x,xxx.xx

Prepared by - R. O. Chapman

Date Prepared 12-13-50

Figure 2 — Illustration shows a typical estimate sheet.

themselves where a regular cleaning program is to be set up. The structural steel must be painted *regularly* with the *proper* protective coatings for the areas or atmospheres involved. Rails should be changed when worn, but should be *always* kept tight both at girder and end-to-end connections and in proper alignment and to the right grade. Runway columns should be kept in repair, their base plates cleaned and above grade, all foundation bolts tight and their concrete footings sound. The runway girders themselves must be checked frequently for loose and missing rivets in all structural connections such as diaphragms, clip angles, etc., and for other structural failures. These must be repaired promptly.


1951

SCHEDULED BUILDING MAINTENANCE

W.O. ORDER CHARGE	WORK ORDER NUMBER	JOB DESCRIPTION	ESTIMATE NUMBER	ESTIMATED COST $ TOTAL	MATERIAL	LABOR	LABOR HOURS CRAFT	HOURS EST	HOURS ACTUAL	TOTAL COST	JANUARY HOURS SCHED	JANUARY HOURS ACTUAL	JANUARY COST	FEBRUARY HOURS SCHED	FEBRUARY HOURS ACTUAL	FEBRUARY COST	MARCH HOURS SCHED	MARCH HOURS ACTUAL	MARCH COST	APR. HOURS SCHED	APR. HOURS ACTUAL	APR. COST	MAY HOURS SCHED	MAY HOURS ACTUAL
B 3693	1753-11	PAINTING 160' CRUSHER BLDG	100	XXXX	XXX	XXX	PAINTER	1000									1000			1000			1000	
B 3695	1753-11	PAINTING & GLAZING SASH	101	XXX	XXX	XXX	PAINTER	1200									153			39			192	
B 3691	1756-11	SASH REPAIR TO 110" MILL	102	XXX	XXX	XXX	MILLWRIGHT MASON HELPER LABORER BRICK	1000									160			160				
B 3690	1757-11	STRUCTURAL REPAIRS TO 160" & 110" FCE BLDG	103	XXXX	XXX	XXX	CARPENTER WELDER RIGGER	396 65 182												396 65 182				
B 3697	1758-11	STRUCTURAL REPAIRS TO 110" SHIPPING CRANE RUNWY	104	XXX	XXX	XXX	CARPENTER RIGGER WELDER ELECT. HELPER	1200 250 80												200 60 20				
B 3695	1759-11	CLEAN & REPAIR RUNS OF PLATE MILLS	105	XXXX	XXX	XXX	RIGGER	1600																

Figure 3 — Jobs are scheduled as indicated on this scheduled building maintenance form.

Safety is one factor common to all types of repair jobs. Work on crane runways may be of a hazardous nature but it can be done safely. Experience has proved that a safety manual specifically stating safety rules applying to crane runway work is a must. It should include specific steps to take in guarding against electrical hazards such as "tagging out switches," "killing" or insulating hot rails, etc. It should insist on the installation of portable rail stops on both sides of the section to be taken out of service, as well as the usual warning flags and lights stretched across the runway. The types of "staging" or scaffolding considered safe for runway work should be covered as well as the precautions to be taken to protect the area below from falling rivets, bolts, burning and welding sparks, etc. It should provide for the use of safety men, preferably chosen from the crafts involved in the job, to ride in the crane cabs with the crane operators when necessary. This is particularly true when the runway may still be in service with the cranes passing by the area of the runway where the repair job is being done. Also, when the repair job has been completed, one responsible person should be appointed to check all work and working areas to make sure that all tools, materials, etc., have been removed and that no loose bolts, nuts, welding rod, etc., have been left which may fall later due to vibration of the crane runway.

Sitting alone at the end of the runway, the rail stops seem to be of little value or concern. However, they can play an important part in the crane and runway maintenance problem, particularly if the crane operators hit them hard and often. It is important that rail stops be set exactly opposite one another on the runway. If they are not so placed and the crane bumps them very often, they will tend to loosen up the crane's "end tie" rivets and cause the crane to become out of line. Then too, there is the trick that operators sometimes use when their cranes are loose structurally and tend to get out of line, and that is to hit the rail stops hard in order to straighten the crane up. Rail stops of the old type that are fastened to the rail and engage the wheel only, are generally not satisfactory, nor are the type that just bolt or rivet to the top flange of the runway girder. On these types, it is a good idea to have a safety cable attached to the stop so that if it is broken loose, it cannot fall from the runway. The modern, and certainly the better type, is of the cast or structural-section design that engages the crane structure or bumper and not the crane wheels, and that is fastened not only to the top of the girder, but also to the bottom of the girder by means of a yoke. Figure 4 illustrates a stop of this type.

Runway rails have been of all sizes and types. Many of them have been too small or the web section too weak for the loads and thrusts imposed upon them. It is recommended that the AISE Standard No. 6 Specifications for Electric Overhead Traveling Cranes (as revised May 1, 1949), Page CS-14, Par. 29-A and D, be used for determining rail sizes. In general, it specifies that only 104-lb, 135-lb, and 171-lb rails be used according to loads imposed and that the lightest be 104-lb (except in special cases). It goes without saying of course, that runway rails, when worn, should be replaced. Excessive wear is generally a sign of improper alignment of either crane or runway, and the trouble

Figure 4 — It is very essential that the rail stop be firmly fastened to the girder.

should be corrected when rails are changed. With the proper organized force and the right equipment, (truck cranes are a big asset), you can change a good many feet of rail in a short time. As much as 897 feet of runway (1794 feet of rail) have been re-railed completely in eight hours. Rail joints perhaps give more trouble than any other single item where rails are concerned.

Rails with hardened ends should be used whenever possible. Also, the gap between rail ends should be held to a minimum, the tighter the better. Standard splice plates and bolts generally allow a fairly large gap; they may also often work loose. A good practice is to use a special splice plate machined to fit tight into the web of the rail and fastened with body-bound bolts in reamed holes with the nuts tack-welded. Splice plates have been welded successfully to the rails at the joints. Also, the welding of the rail ends together, with or without the use of splice plates, is a fairly common practice. However, unless very close control of the welding is maintained, failures may occur. Rail ends that are worn down may be built up by controlled welding with the proper rod and then ground level. Here again, however, unless the rail end is properly prepared and very close control of the welding is used, trouble may develop. Complete description of the various methods and welding techniques employed in the welding of crane runway rails, may be found in a paper entitled, "Welding of Rail Ends and Joints of Crane Runways" by Wray Dudley, Assistant Superintendent of Maintenance, National Tube Co., and published in the "1940 Yearly Proceedings of the AISE." One method which can be used where rail joints are badly worn is to cut off the worn ends, slide all the rails together and then add a piece of new rail at the end of the runway. The joints may be bolted or welded with or without splice plates, as preferred. However, burning the rail ends off with a burning torch is not generally considered good practice, nor is the burning of holes in the web to take the bolts for the splice plates. It is better to saw the rail ends off and drill the holes in the web. Hand sawing is a long and tedious job, but by making a simple rig to hold an air-driven drill steel cutter and shank grinder, to which is attached the proper grade

of cut-off wheel, it is possible to saw through the ball of a 104-lb crane runway rail in 12 to 20 seconds, provided a constant air pressure of about 120 psi is available. The remainder of the rail web and flange can then be cut with a burning torch if desired. Figure 5 illustrates such a rig.

Another item which causes a great deal of trouble is the fastening of the rails to the runway. Here again many methods may be used. The welding of the rail flange to the girder is generally not satisfactory, particularly where there is an appreciable amount of side thrust. Also, when rails have to be changed, it will take quite a long time to burn off the welds from the old rails. Perhaps the most common practice is to burn or drill holes through the top flange of the girder through which a bolt is inserted to hold some form of strap or clip which

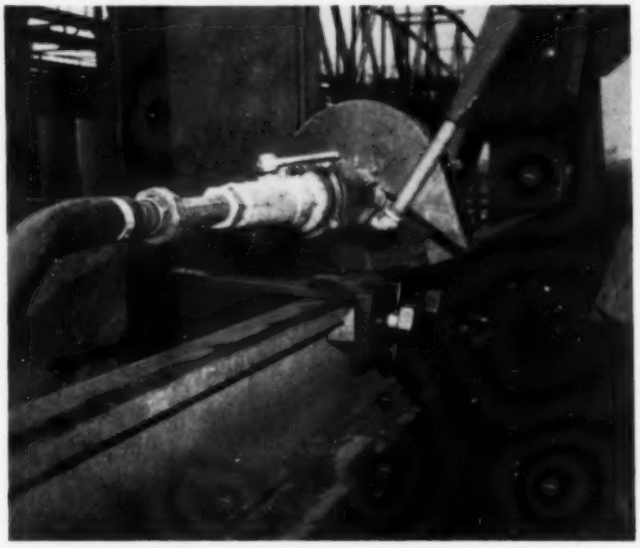


Figure 5 — A power cut-off saw is helpful in runway maintenance.

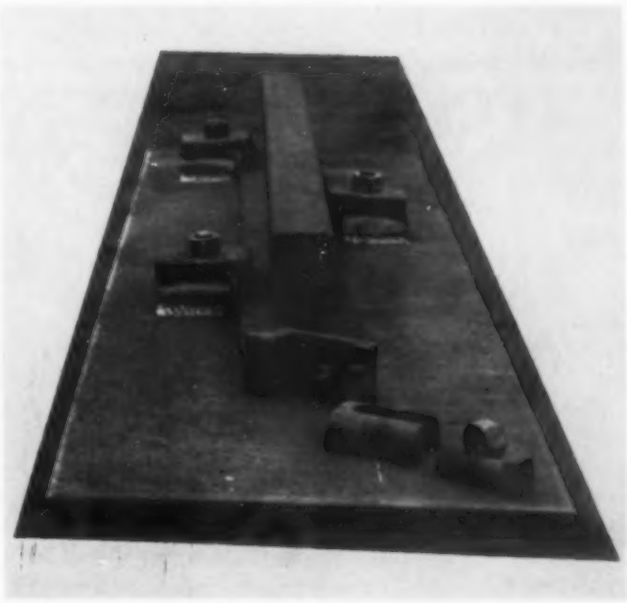
bears on the rail flange. This has several disadvantages. First, the holes, particularly if burned, weaken the girders; second, the bolts may become loose and drop out (possibly on some unsuspecting person's head); third, when changing rails (particularly where adjacent runways have a common walkway plate between them) it is almost impossible to put new bolts in; and fourth, these types of fasteners do not generally furnish much support to the rail under side thrust and if they become loose, the rail will become badly mis-aligned.

Figure 6 shows a type of fastener which overcomes most of these disadvantages. It will be noted that the forged steel "U" shaped clip which is welded to the runway on either side of the rail and set at $\frac{3}{8}$ in. from the flange, will hold the rail in alignment even though the clamp bolt becomes loose. The forged steel clamp which holds the rail firmly in place also furnishes some support for side thrust. The lug on the back of the clamp which mates with the slot in the clip keeps the clamp in the proper position. Also, if the nut works off of the bolt, the bolt cannot fall out nor will the clamp fall off, and on rail changes all bolts can be changed quickly from the top of the girder. This type of fastener, with only one variation in the height of the clip, will fit all sizes of rails from 60 to 171 lb. There is a possibility however, that it may be too high to clear the gearing on some types of cranes.

With regards to the method of bolting up any type of rail fasteners, it is well to remember that an impact wrench used indiscriminately may overstress the bolts and cause them to break off later. Lock washers may also break if the bolts are pulled too tight with the impact wrench and will fall out later, causing a loose bolt. In general, the best rule to follow is to use care in driving up the bolts, not to use lock washers, but tack-weld the nuts.

Practically all crane runway girders, whether of rolled-steel or built-up section, have one or more thicknesses of cover plates which are normally riveted to the top flange of the girder. These cover plates add additional strength to the girder because they increase its effective depth of section. They also take the wear which is caused by the sliding action or the pounding action of the rail. Cover plates should always be used for this reason alone, even if the additional strength is not needed. The first trouble that usually develops is that the rivets in the cover plates become loose or shear off, particularly in open hearth pit crane runways where the girders may have a series of cover plates with rivets 6 to 7 in. in length. These bad rivets should be replaced at once, not only to maintain the strength of the girder, but because the holes (where the rivets are loose) may become elongated, which will necessitate reaming them to the next larger size before re-driving. Loose rivets generally occur more frequently where two adjacent runway girders have a common cover plate or walkway plate extending across the top of both girder flanges. When the flange of the rail has worn down into the cover plate any appreciable amount, it will usually be found that cracks develop in the cover plate between the rivet holes and extend in almost any direction. Cover plates in this condition should be changed as soon as possible because a good deal of the designed strength of the girder has been lost. In some instances on girders where there are several thicknesses of rather heavy cover plates, and where the rail has worn into the top cover plate only, but no

Figure 6 — This rail fastener holds the rail in alignment even when the bolt becomes loose.



cracks or loose rivets are present, it is possible to insert a liner under the rail, fit it into the groove worn by the rail and weld it continuous longitudinally on both side edges. Of course, it is better to change the cover plate if time permits, but this method can be used successfully and will protect the other cover plates underneath that are not yet damaged. On built-up riveted girders of angle and plate construction, if the worn cover plates are not changed soon enough, it will usually be found that the top flange angles will be cracked between rivet holes also, which only proves that the longer the repair job on cover plates is put off, the bigger the job will be when it is finally done. One point of interest regarding the design of girders on outside runways which are exposed to the weather is that the rivet spacing in the cover plates should be a little closer together than is needed for design strength. This will tend to keep the cover plates together tighter, thus minimizing the loss of plate thickness due to rusting and the failure of the rivets due to the expansive pressure of the scale formed between the cover plates.

Because trouble often develops at the diaphragm connections between the crane girders and building column, it is important that these connections be easily

Figure 7 — An inspection door in the runway facilitates inspection and maintenance work.

accessible for regular inspections. This inspection is particularly difficult where girders of adjacent runways are joined with a common walkway cover plate between them. Figure 7 shows an inspection door installed in the walkway plate that makes inspection of the diaphragm much easier, as it is possible to see the condition of the connections from the walkway itself. Also, this door is very useful on repair jobs as air hoses, burning torch lines, tools, etc., may be brought up through it. In most instances the failures to runway girders and connections are not caused by any fault of the original design, but generally because of inadequate maintenance, abuse during operations, or because heavier cranes or heavier loads are being carried by the girders than those for which they were originally designed. For a very good discussion on the design of crane runways see the paper entitled, "Design and Maintenance of Crane Runways," by V. L. Smith, Assistant to Chief Engineer, Fort Pitt Bridge Works,

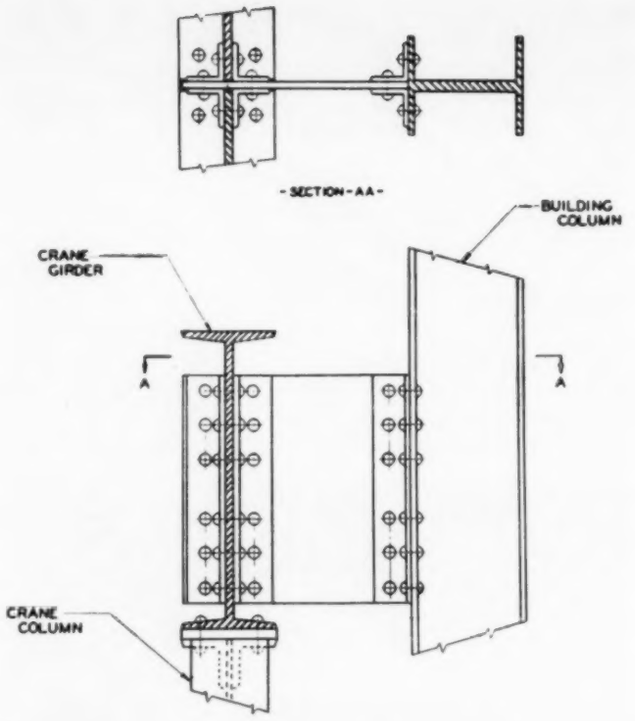
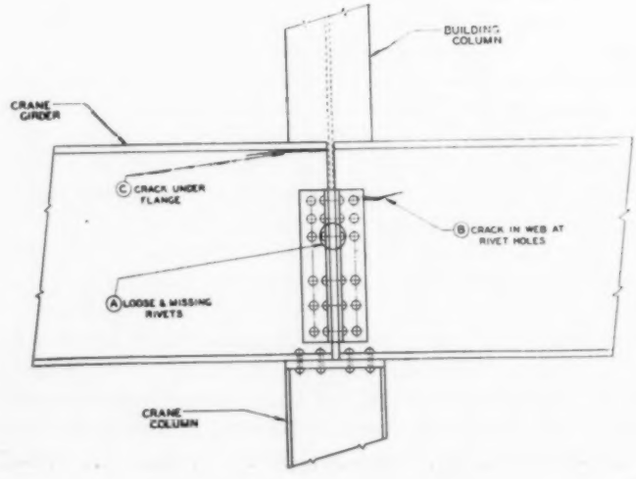


Figure 8 — Sketch shows a typical riveted single plate diaphragm.

published in the "1950 Yearly Proceedings of the AISE."

Figure 8 shows a sketch of the most common type of single-plate diaphragm connection between the end-to-end connections of the girders and the building column. Figure 9 shows a sketch of a different view of the same connection and indicated on the sketch are three types of failures common to this type of connection, namely: "A" loose and sheared rivets in the clip angles which fasten the plate diaphragm and the ends of the girders together, "B" crack in the girder web usually starting at the top rivet hole, "C" crack in web under the top flange of the beam. Usually failures "B" and

Figure 9 — The typical failures which occur in riveted diaphragm connections are shown in this sketch.



"C" occur when the loose or sheared rivets are not replaced promptly. Also, because the clip angles generally are not long enough to give the support necessary to the bending action imposed on the upper section of the web of the girder by the thrusts from the cranes. If failure of rivets at this point occurs frequently, consideration should be given to replacing them with heat-treated high tensile strength body-bound bolts. On many new installations, this type of bolt is specified instead of rivets. The cracks as indicated at "B" and "C" should be repaired by first drilling a hole at the end of the crack to prevent it from spreading further, then properly welding the crack as well as the hole. To further insure that the girder will not crack again, the ends of the girder should be stiffened by an appropriate-size vertical plate or flat bar stiffener fitted to the contour of the beam from flange to flange. This flat bar is set at right angles to the web of the beam and in line with the flange of the runway columns as shown in Figure 10.

There are times under certain severe mill operating conditions or overloaded conditions above original de-

Figure 10 — Vertical stiffeners should be placed in line with the flanges of the runway columns.

sign, where the conventional-type, single-plate riveted diaphragm connection just cannot be kept in satisfactory repair at reasonable maintenance costs. If so, the best solution is to re-design the whole diaphragm connection. One type that has proved successful is the double-plate, welded-type diaphragm as illustrated in Figure 11. This type, it will be noted, supports the end of each girder individually and allows for some movement and deflection of the girders independent of one another as well as stiffening the end of the girder and eliminating the problem of sheared rivets and cracks in the girder web. The movement is absorbed by the flexing action of the plate connecting the end of the girder to the building column. To install this type of double diaphragm, it is necessary to remove the old single-plate diaphragm together with the clip angles at the building column and girder, and weld up the rivet holes. Next, enough should be cut off of the ends of each crane girder to allow clearance for the two plates. These plates should be as deep as the web section of the girder and extend in length far enough past

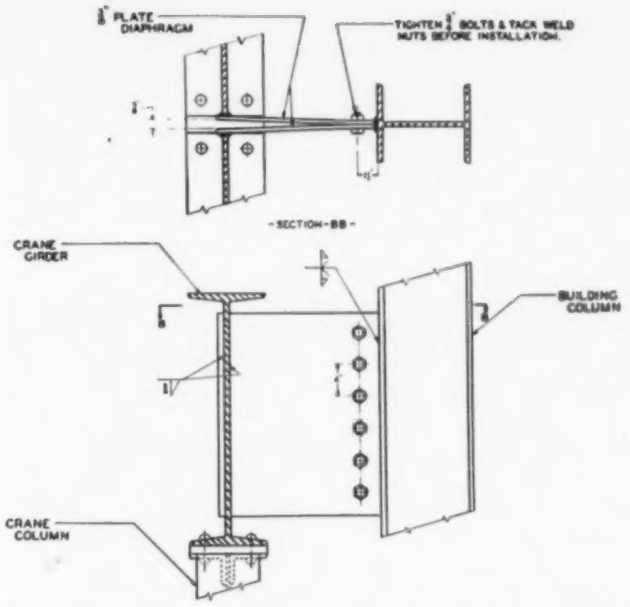


Figure 11 — Sketch shows a typical design of a double plate welded diaphragm.

the web end to allow for a good fillet weld on both sides of the web to the plate. The thickness, of course, has to be determined for each application, but generally ⅜-in. plate will be found satisfactory. These two plates which have been bolted together tightly near the ends that are to be welded to the building column, are then slipped into place and fillet welded to the building column as shown. Next the ends of the plates between the girder ends are wedged apart the ⅜-in. allowed for expansion which will force each plate tight against the end of the girder it is to support. Each plate is then welded to its mating girder for the full depth on both sides of the web and the wedges removed. If a good welding job is done, this type of connection should give years of trouble-free service.

Another design which incorporates the same idea in a slightly different manner is shown in Figure 12. This design is generally employed on the deeper built-up type of girders for heavy duty service such as open

Figure 12 — General view of a "knuckled type" diaphragm.

hearth pit and floor crane runways, and where there is likely to be increased deflection and longitudinal movement of the girders. Here, as can be seen from Figure 13, a right angle "knuckled" plate is used to fasten each girder individually to the building column after the straight plate diaphragm has been removed. The short end or the end closest to the knuckle is riveted to the flange of the building column and the other end is riveted to a clip angle on the girder near its end. The cap rivets of the supporting column are removed and guide blocks welded on the cap of column on either

Figure 13 — The "knuckled type" diaphragm is generally employed in the deeper built-up girders.

side of the girder flange. This is much the same as the standard expansion joint construction. Also, the walkway cover plate, if one is present, is cut loose from the building column and supported by a clip riveted to the top edge of the knuckled diaphragm plate. Movement of the girder is taken up in the flexing of the plate at the knuckle, thus the rivets are not overstressed.

There is one other type of failure of the runway structures that should be discussed, and that is the failure of the main runway girder, by it literally breaking in half, generally at or near the center of the span, even though, according to original design calculations, it was adequate for the loads imposed. This generally, although not always, occurs in the "rolled" type girder rather than in one of the plate and angle construction. Almost invariably the cause can be traced to a hole that some thoughtless workmen had burned in the bottom flange or web of the girder with a burning torch. It seems to have been a common, although "criminal" practice, for workmen to burn large ragged holes in crane girders in order to hang pipe lines or electric cables, attach slings for lifting, etc. Whenever holes of this nature are present, particularly near the center of the span, failure of the girder will result sooner or later. When detected, they should be properly welded up or reinforced immediately. If failure of the girder occurs in this manner, the simplest and safest repair is to jack the girder back up to grade, properly weld the crack, and then weld a "doubler" plate under the bottom flange. This is illustrated in Figure 14. This "doubler" plate should be about 1 in. wider than the bottom flange so that it may be easily "downhand" welded along both edges of the flange and it should extend for almost the full distance between supporting columns. It should not be welded to the bottom flange of the girder at its ends. If the "doubler" plate used is only a short "patch" plate put on only under the cracked section and welded at the ends, the girder may fail again, this time at the end of the plate. This of course, is caused by the sharp change of section and the stresses imposed by the welding at the end of the plate not being able to withstand the deflecting action of the girder. "Doubler" plates can also be installed on one or both sides of the web at the crack, but it is felt that the "doubler" plate under the bottom flange is the best method.

Mis-alignment of crane runway girders normally does not cause too many serious failures of the runway structure, but it can cause a lot of trouble to crane operation. Variations in gauge between rails, unless great, can normally be taken care of by re-aligning the rails, although care must be taken not to get the center of the rail too far from the center of the girder. Improper elevation is normally caused by the runway and building column foundation settling. This can be corrected: (a) by putting liners under the rail, (b) by putting shims between the girder and the top of the runway column or extending the runway column section, and (c) by jacking up the runway column, together with the building column if such be the case, installing liners under the base plate of the column and then re-grouting. Method (c) is the best. Figure 15 shows a runway that had settled badly and Figure 16 shows the same runway near the end of jacking operations. This particular job as can be realized from the pictures, was a rather difficult one as it involved jacking double columns that supported both pit and floor crane runways as well as the building structure of an

Figure 14 — A crack in the web was repaired by adding a doubler plate in the bottom of the flange.

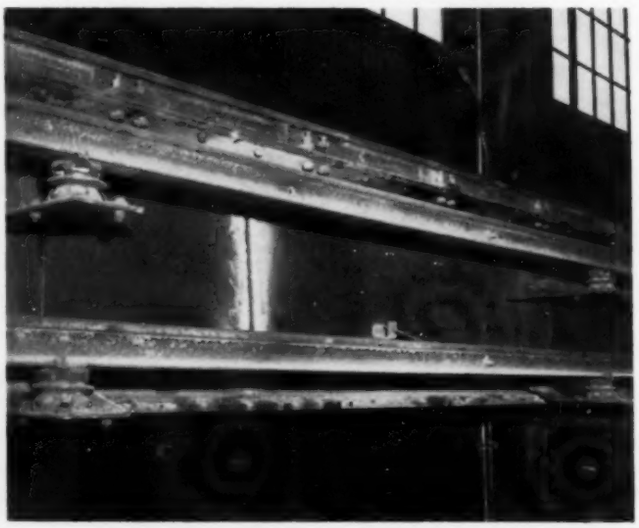


Figure 15 — View shows open hearth runway before re-alignment.

Figure 16 — View shows open hearth runway of Figure 15 after re-alignment.

open hearth shop. A paper covering the details of this job by M. F. Reese follows this one.

In order to keep runway columns plumb and to prevent damage to flanges, it is sometimes necessary to install guards or bulkheads around them to prevent their being damaged or being struck by loads being handled by the cranes. Figure 17 shows damage that can result if such precautions are not taken.

While discussing supporting columns, it is well to mention again that their base plates should be kept clean and the foundation bolts tight, and the concrete footings in sound condition and above grade. Too often the yard level grows with the years and the bottom of the columns become buried, and in the course of time, they will corrode away to the point of failure. Many times, in an effort to correct this condition, the bottom of the columns will be enclosed in brick or concrete. This can sometimes be a serious mistake because unless the steel is cleaned well and a perfect bond is made between the brick or concrete and the steel, moisture will attack the steel where no one can see it and corrode it away and failure will occur. The better method is to lower the general yard level and keep the steel cleaned and painted, or, if this is not possible, fabricate a new base plate around the column higher up, extend the foundation bolts and then form and pour the concrete around the column under the new base plate. This is the safe method because, should the column corrode behind the new concrete, the load will be taken by the new base plate.

In conclusion it is well to point out again that by having an adequate and well organized building repair organization, by employing a careful inspection program, by making the correct analysis of each particular problem, and by following through with the proper planning of each job, the difficult and often neglected work of crane runway maintenance can be successfully accomplished.

Figure 17 — The bottoms of column should be protected.

DISCUSSION

PRESENTED BY

S. C. READ, Director Construction and Maintenance, Jones & Laughlin Steel Corp., Gateway Center, Pittsburgh, Pa.

W. J. TUNNY, Superintendent Electrical Maintenance, Youngstown Sheet & Tube Co., East Chicago, Ind.

H. R. KNUST, Superintendent Mechanical Dept., Bethlehem Steel Co., Sparrows Point, Baltimore, Md.

ERIC TAYLOR, Chief Electrician, Atlas Steels, Ltd., Welland, Ontario, Canada.

F. J. GAYDOS, General Foreman Welding, United States Steel Co., Gary Works, Gary, Ind.

S. C. Read: I heartily support a regular scheduled inspection of crane runways as a necessary part of plant maintenance. On these crane runways, which are used at a higher rate of speed today, rivets become loose and web plates crack.

To overcome these things, our maintenance people have established what they call a building maintenance survey. In December and January they make a thorough inspection of their buildings, which includes the runway and also the crane girders. The results of this building maintenance survey are used for several purposes—to work up the annual maintenance budget, to procure the material needed for repairs and then to schedule the work as efficiently as possible.

Today there are many improvements incorporated into the design of new plants—building piers are supported on piling, the crane runway girders are made stronger and more massive, and heavier rails are being used.

W. J. Tunny: We use reamed joints with body bound bolts on our running rails. We have done some electric welding at joints to fill up the wear, but only in an emergency. This did not hold up very long due to eventual cracking of the weld. We use wearing plates as they greatly extend the life of the structure.

Member: The author commented briefly on the cleaning of crane runways being quite a problem. I would be interested in knowing whether he does that cleaning by mill labor from the property involved, or whether a gang from the central shop does it or whether a gang does it on contract; that is, whether it is done by outside contractor forces.

H. R. Knust: Some like to have one rail fixed and the other floating, others like to have both rails float and still others prefer both rails fixed. We at Sparrows Point, I believe, prefer to have both rails fixed, because they generally get loose in time anyway. With the type of rail clamp and clip as described in the paper, the rails are held in alignment at all times and I believe the clamps, although bolted tight, will allow longitudinal growth as required.

Regarding the question of cleaning runways, first let me state that it is done by our plant personnel, not contracted. In some cases it is done by mill operating personnel, in others by the electrical department, and in still others it is done by the central mechanical group on a works order from the department involved. We try to put the emphasis on each department keeping their own runways clean.

Eric Taylor: We got into considerable trouble in our soaking pit building with rail-holding clamps and I did not realize that we had done something apparently original. We cut off some pieces of heavy gauge 3-in. angle iron, as heavy as we could get, about 3-in. long and welded them down with the heel of the angle against the rail. We then heated the vertical portion of the angle and pounded it down over the rail. Naturally, we do not get a tight clamp, the rail can ride to and fro. This construction has been in that building now for a year and we have had no difficulty with it of any kind. If we ever had to replace a rail, I would propose that we just cut off the piece of the angle which is bent over the flange, put a new rail in, and weld some new pieces of angle a little further along the crane beam rather than cut off the entire cold piece of angle.

H. R. Knust: I see nothing wrong with the type of clips described by Mr. Taylor. As I mentioned, there are all sizes and types of rail-holding devices. We have found that the one described in this paper suits our needs best for the reasons outlined.

F. J. Gaydos: I would like to comment on the welding of rails. We did have considerable trouble in the welding of rails at one time or another due to the manganese content and also the high carbon content of the rails. Since World War II, the Navy has allowed us to use welding rods (which we could not get otherwise) known as low-hydrogen rods, and we have had better success. They are having considerable success in welding some of these so-called "odd" steel plates, which are low alloys and armor plate with No. 9016, No. 100-16, and the No. 12-16 rods. It was found that a cracking condition came about, due to the fact that steel above thirty-five or forty carbon becomes hardenable. In other words, it heat treats itself, under some conditions of use and during welding; it was also found that hydrogen was the principal ingredient that caused the trouble in welding of high-carbon steel and rail steel.

Now it is possible to produce a very "dry" coating to get rid of the hydrogen in the coating of electrodes, thus, preventing undue underhead hardness on welded high-carbon steel. We have done welding on our ore unloader rails when the rails have broken, and of course, this in mid-season when you need all you can get out of them. We pre-heat the rails to about 400 F burn, and weld with a low-hydrogen electrode, preferably in the No. 9016 category.

After we get through with this welding operation, using heating torches all the time to keep it hot, we put on the last couple of passes of nickel-manganese. Right now that is out of the question, but you can use moly-manganese. Then bury the welded area in expanded mica for four or five hours and you wind up with a successful weld that should be able to get through a season of unloading ore.

Whether the operators changed the rails at the end of the season, I do not know, but we have welded the rails and they were there and going.

Now, I understand that Bethlehem does weld their rail joints instead of using bolted plates, the joints being welded with low-hydrogen electrodes.

I would suggest to anybody who wants to experiment with welding of rails that they do use the low-hydrogen electrodes, which are in the 15 or 16 categories of the American Welding Society.

H. R. Knust: Regarding Mr. Gaydos' remarks on the welding of rails, first let me make it clear that in the paper I am speaking of the Sparrows Point plant only and not for the whole Bethlehem Corporation. We have done some welding of rails at Sparrows Point but so far we are not too much in favor of it.

Briefly, our practice for electric arc welding of the butt joints is to double vee bevel the web and single bevel the flange from the top. Preheat to 250-300 F and weld flange with 18-8 stainless rod and the web with No. E-6010 or similar rod. Then the ball is single beveled from the top, preheated, and welded with 18-8 stainless rod and ground smooth.

REALIGNING CRANE RUNWAYS in an Open Hearth Building

By M. F. REESE, JR.
Foreman, Steel Erectors
Mechanical Maintenance Department
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. . . . by jacking up the building columns of an open hearth building to eliminate irregularities, operation has been improved and maintenance reduced . . . .

▲ THE No. 1 open hearth building at the Sparrows Point plant of Bethlehem Steel Co. had settled from its original elevation. This seriously interfered with the open hearth operations. There was excessive maintenance on the pit and floor cranes resulting from the twisting and racking of their structures and more than

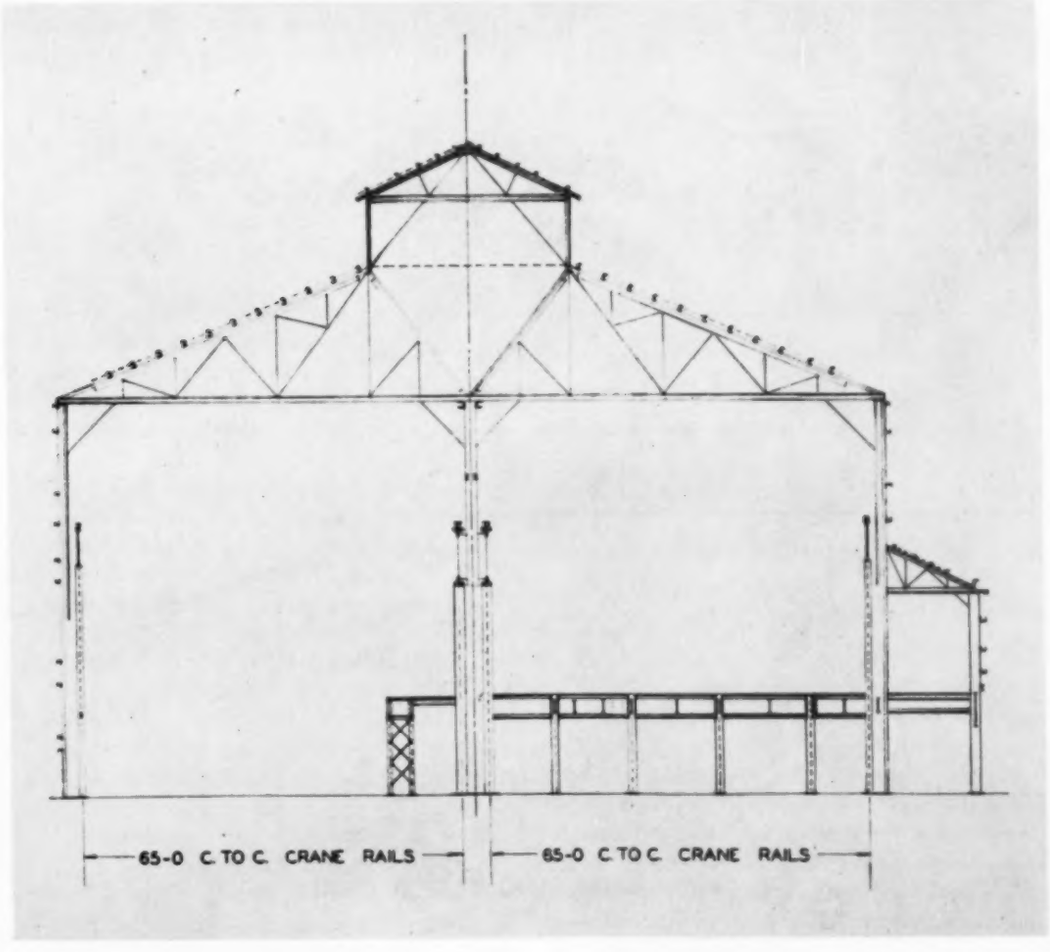


Figure 1—Cross-section elevation through No. 1 open hearth building.

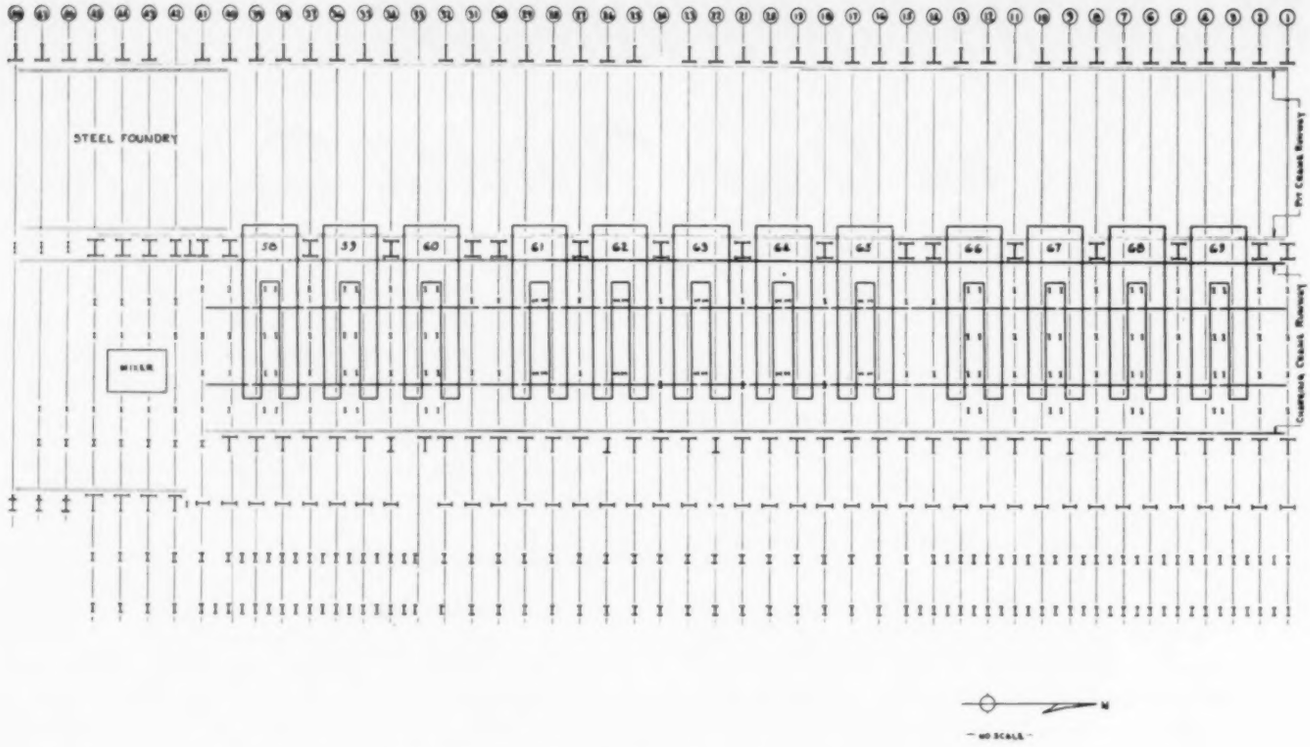
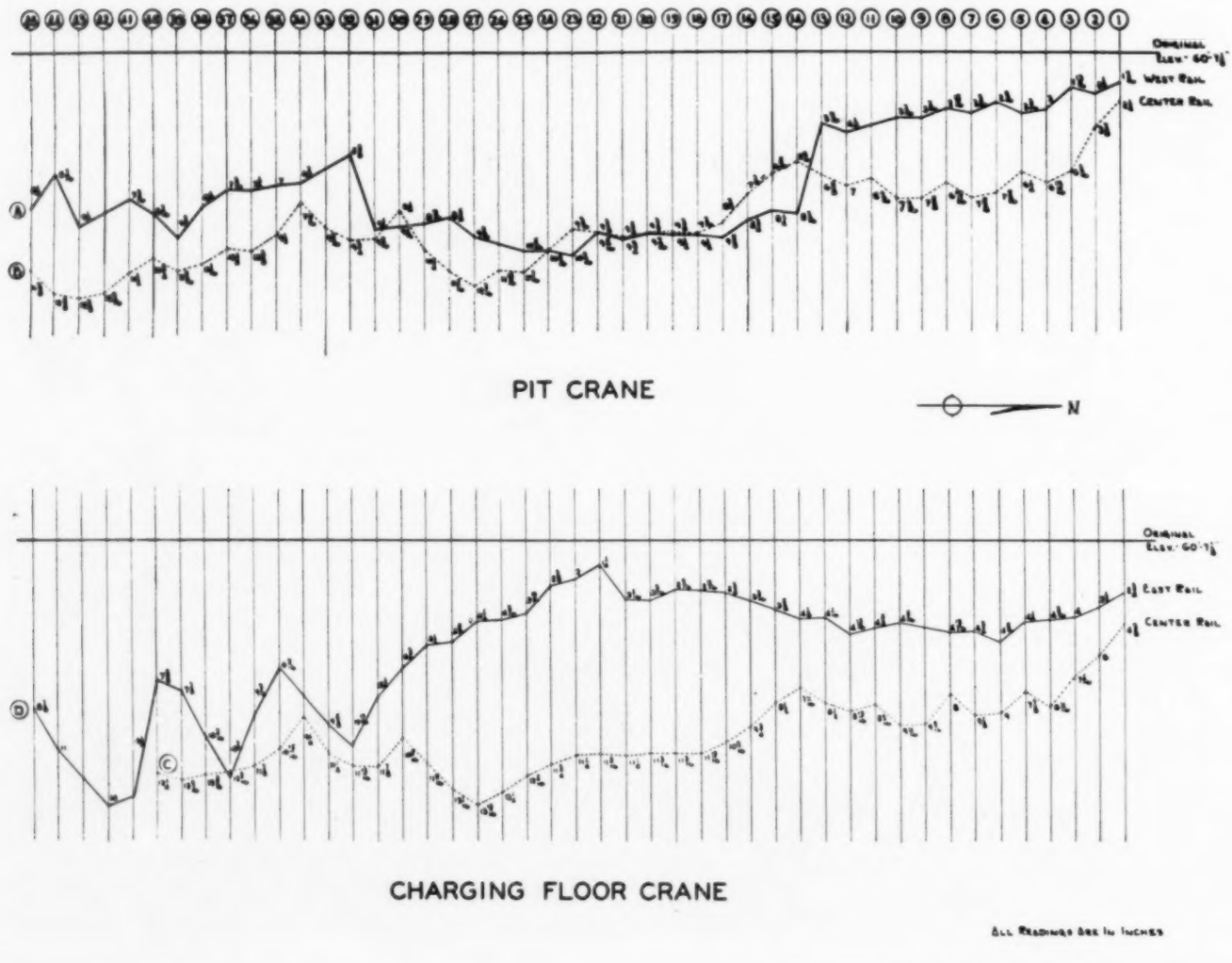


Figure 2 — Column plan for No. 1 open hearth building.

Figure 3 — Settlement had been very irregular as shown by these profiles.



normal wheel and truck replacement. The waste-heat boilers were out of level, the charging machines were having difficulty raising the pans high enough to charge the furnace, and the hot-metal cars as well as the cranes all drifted to the lower part of the building.

Before going any further, it might be well to give a brief physical description of the building which is referred to as No. 1 open hearth. The original building, built in the years 1909-10 housed five furnaces. In 1921-22 a four furnace addition was built at the north end and in 1925-26 a three furnace addition at the south end. This made a total of twelve furnaces in the shop. These are serviced by five pit cranes and four floor cranes. Also on the floor are four charging machines, and in the south half of the building, on the charging floor, is a standard-gauge railroad track used as a transfer track by the hot-metal cars. The building also houses a hot-metal mixer and a steel foundry. It is arranged with the pit cranes and floor cranes using a common center runway. Thus there are three main rows of crane-runway columns, one supporting the east floor crane runway, a second supporting the west pit-crane runway and the third, down the center, supporting the runway used jointly by the pit and the floor cranes. The charging floor is supported on four rows of columns of a much smaller size than the three main rows. These features are shown in Figures 1 and 2. The furnaces proper were designed to be independent of the floor and building structure. Through the years, however, various repairs or alterations had connected them to the building structure.

Waste-heat boilers are operated in conjunction with each furnace. These boilers are connected to and supported by the building structure. The usual miscellaneous services carried in pipes, conduit, and ducts are also attached to the building structure. Late in 1947 and in the early part of 1948, the engineering department made a survey of the building. The result of this survey showed that it was definitely sinking at the south end. In some places this sinking amounted to as much as 15-in. Apparently, the extreme north end of the building had not settled. The settling was very uneven. The results of this survey are given in Figure 3. The problem of how to correct this condition was given to the mechanical department and they were asked to see if some solution could be reached. The job was considered, at this time, to be primarily one for the steel erectors and some of the supervision in this craft undertook a study of the problem. There were three methods proposed in this study and these were:

1. Insert liners under the rails.
2. Disconnect the crane runways at the column tops and put filler pieces under them to level the rail.
3. Elevate the columns from their footing and place shims under them to get the desired elevation.

The first two proposals were eliminated with very little further consideration. Either would only correct the trouble experienced with the cranes and not the other results of building settlement. Furthermore, they would involve a partial shut-down of the mill, which was not possible at this time. This left plan No. 3 to be studied in detail. Although at first glance this seemed to be a very elaborate and extensive job, investigations proved that it was possible and feasible. The first consideration necessary to the planning of this job was to calculate the live and dead loads on the building columns. These were obtained from the engineering department and are shown in Figure 4. Along with this consideration of loads, and paralleling it, a study was inaugurated to determine where the raising load should be applied to the base of the columns in order to avoid putting undue strains and stresses on the column members. The drawings of the footings were obtained and analyzed at this time. These showed that under the main columns clusters of piles had been driven, some

MAXIMUM LIVE & DEAD COLUMN LOAD IN KIPS
ONE KIP = 1000

COLUMN LINE / COLUMN NUMBER	C	D	F
1	716	2230	680
2	851	1870	901
3	808	1976	673
4	944	2262	632
5	373	2293	897
6	991	2290	984
7	1038	1290	846
8	1152	837	859
9	509		928
10	910		1035
11	924		960
12	767		669
13	938		
14	335		25

DEAD LOAD ONLY — KIPS

COLUMN LINE / COLUMN NUMBER	C	D	F
1	241	515	60
2	376	155	96
3	333	261	53
4	469	547	12
5		578	92
6	358	575	79
7	663	500	226
8	677		239
9	32		308
10	435		230
11	358		155
12	292		49
13	463		

Figure 4 — Building column loads are given in these tables.

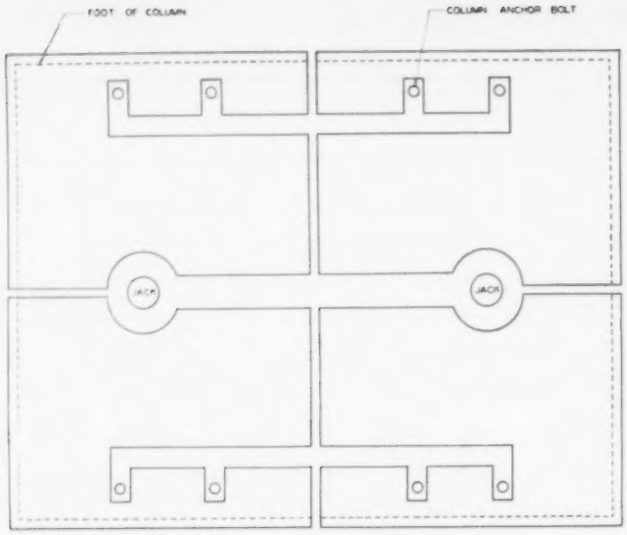


Figure 5 — The liner plate which was used is shown in this sketch.

into the original earth and others into a fill which in most cases had been hot poured slag. In all cases the piles had been driven far enough to get to a strata figured sufficiently strong to bear the load. It is believed that the points of the pilings punctured this strata causing the sinking of the building. The pilings were capped with normal concrete slabs and footings. These footings had sufficient area and the concrete sufficient strength to permit pockets to be cut in them to support the jacks which were available for raising the building.

A survey of equipment on hand was made and it was decided to use 100-ton capacity hydraulic jacks augmented, where necessary, with 50-ton jacks. These jacks were to be used to apply the main lifting force, with steel wedges driven with mauls used where possible to augment them or to snub the load if the hydraulic system failed. Shims or liner plates were designed to be placed under the footings with the jacks still in place. This necessitated putting the liner plates in position in several pieces. A typical design of a liner plate is shown in Figure 5. It was also found that it would be necessary to extend the column anchor bolts in some places and this was taken care of by welding extensions to the existing bolts and using plate washers under the nuts. Along with the consideration of raising the three main rows of columns and the four supplementary rows, a study was made of the items which would have to move with columns, in addition to the building members. This list was very long, some of the items being: air, gas and steam lines, pneumatic tubes, electrical conduits, and in some cases open electrical lines, fuel lines and last but not the least, the waste-heat boilers. These boilers rest on the charging floor with their casings extending down through the charging floor and on down through the cellar floors into the flues of the furnaces. The superheat steam lines were also supported from the floor and extended down into the furnace flues. The induced-draft fans were connected to the furnace stacks, which were not connected to the floor, but the induced-draft fan motors and footings were fastened to the floor. Surveying a large part of the building, it was found that all of these services could be moved by readjusting brackets, etc. The most critical items were the steam lines from the superheaters, but it was believed that they would take some deflection when the boiler was raised since they had already deflected as the boiler sank.

At this time a job plan was written for the entire operation. This was done, studied, and revised as needed. When the revision was finished a job plan con-

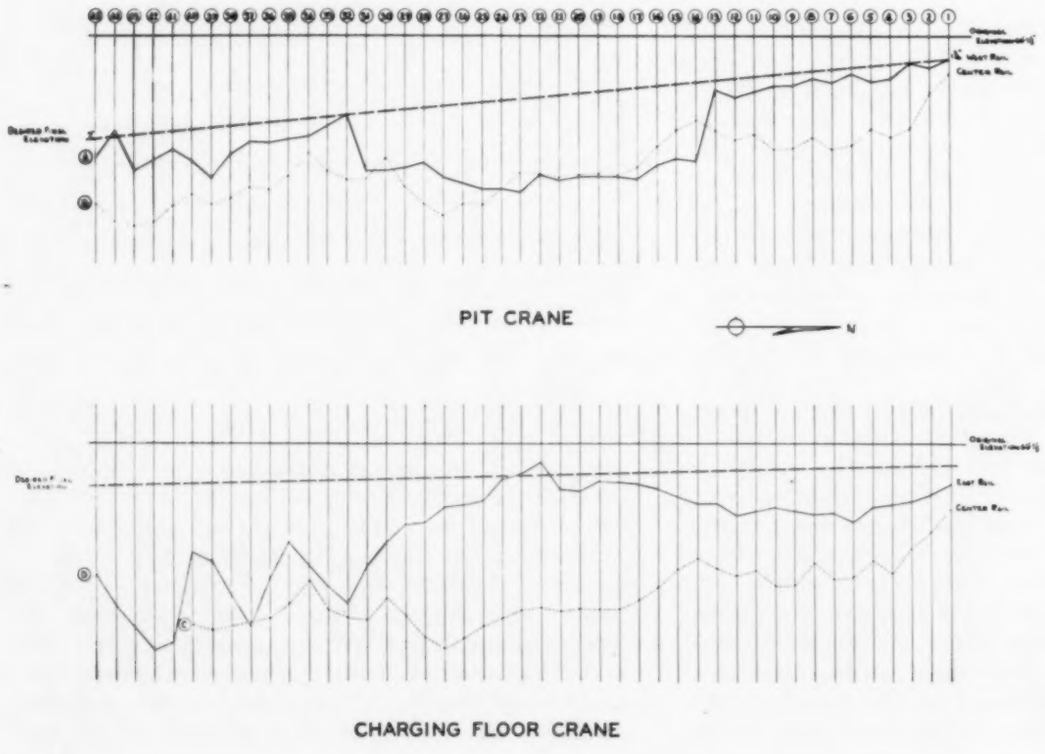


Figure 6 — It was decided not to attempt to bring the columns back to their original elevation but rather to eliminate the variations in the runways.

ference was called at which time personnel of the mechanical department, the operating department, the electrical department, and the engineering department held a joint discussion at which all the factors involved in the job were discussed and agreed upon. At that time it was decided that the plan would be put into effect. This group also discussed the man-power requirements and estimated the duration of the job. It was hoped that the job would progress at the rate of a column a day.

The feasibility of bringing the building back to its original elevation was considered and the opinion of the management was that the cost would not justify the results. The final decision was to straighten out the dips and humps in the crane runway and building. The final elevation of the building was to be ⅛-in. slope in 25 ft, starting with the north end of the building at its present elevation. The results expected are plotted against the existing elevations of the three crane runways on Figure 6. With the consideration in mind of eliminating undue stress in the structural members, no column was to be jacked more than 2-in. at any move. This would mean coming back and in some cases raising the same column several times. The decision where to start was not a difficult one to make since the lowest section was under the center crane runway at the south end of the building, adjacent to the steel foundry. The job was to start at these lowest columns and fan out in all directions as needed to bring up the building and at the same time keep from putting any more stress than needed in the members of the building while being raised.

Figure 7 — View from east side of column D37 (double runway column between 58 and 59 furnace) shows positioning of 100-ton jack just at the start of pumping. Note the two heel wedges started indicating that the seal between the base plate and the footing has broken.

Figure 8 — West view of column D37 just as it starts up. The 6-in. ruler resting on the base is shown for comparison. Note the extension welded to the anchor bolts to allow the base to rise 4-in.

Work was started on this basis in January, 1950. Approximately 12 x 12-in. holes were cut in the concrete footings and the hydraulic jacks were inserted. The necessary liners were on hand. The anchor bolts were loosened and the actual jacking operation started. This column had a total load of 650 tons and a live load of 230 tons. The jacking operation was scheduled so that when a column was being raised there would be no cranes over the bay in which the work was being done. Two 8-in. diam. jacks of 100-ton capacity each, and one 4-in. diam. jack of 50-ton capacity were placed in their respective pockets in the footing. Each jack was piped to its own hydraulic pump. Gauges were installed on each pump to allow a uniform pressure to be exerted on the base of the column. At 8,000 psi pressure on the gauge, the column started to move. This 8,000 psi pressure represented approximately 80 tons on the 100-ton jacks and 40 tons on the 50-ton jack. When the column had risen an inch and one-half, motion stopped. Further pressure would not move it. Investigation proved that the column was restrained by the adjacent columns to the north and south, a distance of twenty-five feet away in each case. The anchor bolts on these columns were loosened and the column came free of the footings without any force being applied, showing that they had definitely restrained the motion of the original column. Pressure was then again put on the jacks under the original column and the last half inch was easily obtained. From this experience the procedure was set up that when any columns were to be moved, the adjacent columns on all sides were to be free from

their footings. Only in the case of the heaviest loaded columns was it necessary to jack more than one column at one time.

Figure 7 shows two 100-ton jacks under a center crane runway column. This illustration has several points of interest. The column identification mark can be seen and under it the amount the column has to be raised in inches. The extensions welded to the anchor bolts show plainly and so do the heel wedges used to follow the jacks. The small block and fall was used in placing and handling the hydraulic jacks. Figure 8 shows the opposite side of the same column as well as

Figure 9 — New footings were poured after the columns were raised.

the wedges and the extensions to the anchor bolts. For comparison purposes, a 6-in. rule is shown at the base of the column. The structures on each side of the column are the side walls of the slag pockets and checker chambers of the open hearth furnaces. After the column had been raised the necessary distance and liners inserted, the jacks and wedges were removed, the anchor bolts tightened and the footings prepared for repouring.

Figure 11 — Method of raising a small (load less than 100 tons) column using jacking brackets welded to the column and the floor for footing. Jack marked "J1" is rated at 50 tons, other jack at 100 tons. Both ratings are at 10,000 psi gage. Pipe columns under the jacks were later done away with in favor of square boxes made of ¾-in. plate.

Figure 9 shows such a footing with the reinforcing rod in place and the form ready to be poured. Figure 10 shows the footing repoured, the form stripped but not cleaned and not back filled. On certain of the smaller columns carrying the floor it was not necessary to cut pockets in the footings. These columns were raised by

Figure 10 — View shows footings after the concrete has been poured.

Figure 12 — It was necessary to cut the concrete floor to allow movement of various pieces of equipment.

fabricating jacking pads and welding them to the sides of the columns. Jacks were then put under these brackets and pressure applied. Figure 11 clearly shows a typical set-up using this method of raising the column. In most cases it was necessary to cut away the protective

concrete which had been poured at the base of the column to allow access to the anchor bolts. The two jacks shown in this picture are of 50 and 100-ton capacity, the one on the left being the larger. The difference in the size of the jacks was compensated for by pressure regulation.

The boilers were secured with additional reinforcement to the charging floors steel work. Since the casing went through the concrete floor into the flues, it was necessary to cut the concrete to allow movement. No difficulty was experienced. Figure 12 shows where such a casing had been raised out of its pit and was being prepared for the repair of the casing and repouring of the concrete. The connection between the boiler exhaust fan and the stack of the furnace was cut, and after the boilers had come to their new elevation, this joint was remade with wrapper plates. Induced-draft fans were realigned and leveled. There was no difficulty experienced in any part of the total job in the way of pipe or structural failure. After each column had been moved, and in fact, while it was moving, the building foreman were on hand continuously observing the building structural members for evidence of undue strain. In most cases the trusses, chord and diagonals of the roof structure had shown some deformation, and as the columns rose this disappeared.

The job was completed in June, 1950. At the present time it appears that it was thoroughly successful. The boilers are level. The hot-metal cars and cranes no longer drift. The charging machines are now able to charge the furnaces normally, and the electrical department reports that their cranes appear to be operating much more smoothly. It is too early to give a complete report on what effect this operation will have on crane maintenance, but it is expected to reduce these costs considerably.

The job is an example of the value of preparing and working a comprehensive job plan. The operation was a success due to the cooperation and advice of all the departments concerned in the original detailed planning of the job and their wholehearted cooperation during its progress. The job plan, in general, was followed for the entire job. Slight modifications, of course, arose from time to time, but this was to be expected in a job of this magnitude.

DISCUSSION

PRESENTED BY

CHARLES W. BOYLE, General Assistant to President, F. E. Smith, Inc., Philadelphia, Pa.

J. A. BELL, Chief Engineer, Bethlehem Steel Co., Bethlehem, Pa.

M. F. REESE, JR., Foreman, Steel Erectors, Mechanical Maintenance Department, Bethlehem Steel Co., Sparrows Point, Md.

Charles W. Boyle: I would like to know what they did to relieve the welds when they jacked up on the smaller columns?

J. A. Bell: I note that Mr. Reese refers particularly to the alignment of crane runways in reference to both change of span and variation in elevation of rails. These two conditions are what might be termed routine problems in alignment of building structures.

It is well known that with the continual racking of the loaded trolleys on both the charging floor and the pit side, there is a tendency for most open hearth buildings to develop a lean in that one direction, unless properly designed to meet this particular condition.

I would like to ask Mr. Reese if he has had a condition where both the open hearth building and crane columns were out of plumb as much as 9-in. from the runway rail to the column base, and if so, what was done to get building back into proper alignment.

M. F. Reese, Jr.: As to relieving welds on the jacking brackets, etc., I do not know whether we were gifted with good welders or super rods, but those brackets were made of ¾-in. plate, and following the welding departments advice on the preparation of the welding joint, we did not have to relieve the weld joint. They took all the strain we could give them. I do not remember that we tore a welded bracket loose or showed any signs of failure. We distorted some of the plates; we bent some gussets but we had no weld failures.

Mr. Bell, is worrying about the rails, not for vertical elevation, but for alignment. We are very fortunate down at the point in that a rail clamp has been developed which allows us to correct misalignment of rails up to as much as a half inch. It is a welded horseshoe forging which we weld to the crane cover plate and it has a forged clamp that grips the rail down. The assembly bolts together.

These particular crane runways we talked about were very much out of parallel when we started jacking, but we found when we brought them up to elevation that the alignment of the rails improved to a very great extent. It improved to such an extent that a problem which we had thought was a secondary problem of almost as great a magnitude as the first, that of restoring the gage, disappeared almost completely.

I would suggest that you check elevation. Maybe that is so bad that it is throwing out your alignment. As you say, 15-in. is not much for you, so we can assume your elevations are out and that is contributing to the misalignment of the runways.

We have had at Sparrows Point crane runway rails which have shifted so badly out of alignment that it is necessary to relocate them on the girder. If the girder is a box section, no alterations are made to it, but if the girder is a "T" or "I" section, either fabricated or rolled, we have found it necessary to install vertical stiffeners on the side of the girder to which the rail was shifted. The spacing of these vertical stiffeners varies with the service and load. I know that some of the "slide rule" engineers will hold up their hands in horror at this eccentric loading of a beam, but as maintenance men we have found that the practice will work. In all cases an investigation tries to determine the cause of the realignment and if possible corrective steps are taken.

Submerged Arc Welding

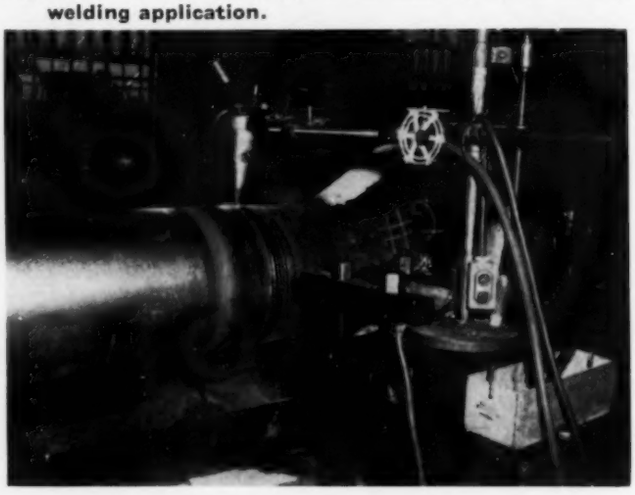
By O. M. FROMM
General Foreman
Electric Welding
Bethlehem Steel Co.
Sparrows Point, Md.

. . . . ingenuity in the application of welding equipment results in economical repairs . . . .

▲ DURING the past six to eight years, the submerged-arc welding process has played a prominent part in maintenance and reclamation welding at the Sparrows Point plant of Bethlehem Steel Co. The evolution of automatic welding has been from a fully automatic bare electrode process, through coated-electrode automatic welding to the submerged-arc process. Through the years, additional equipment has been procured, until at the present time there are in the Sparrows Point plant three fully automatic submerged-arc welding set-ups, one coated-electrode automatic rig and four semi-automatic submerged-arc welders of various types and manufacture. This paper will deal principally with the semi-automatic submerged-arc welding process when used in conjunction with jigs and positioners. When the semi-automatic submerged arc process was first introduced, it was designed primarily for flat position or downhand welding, and as such it was, and still is, a very efficient and time saving process. The welding department at our plant is a maintenance department, and as such does not have too many jobs where the original intent of this process would be applicable. However, necessity being the mother of invention, and with the plant being faced with increased work and man power becoming less and less available, the idea of converting the semi-automatic process to a method that would be as fully automatic as possible was conceived. In order to make this change, the possibilities of jigs, radiagraph machines, and positioners were explored, two small positioners were renovated and fitted with gear reductions and rheostats to provide control of the rpm, and a larger positioner was purchased to handle the heavier jobs. The next step in this conversion was the fabrication of a jig which will hereafter be known as an inching jig. This jig consists of a vertical and a horizontal bar with screw adjustments on each, so that the height and length of each respective bar can be governed. The welding head of the semi-automatic welder can then be placed in a bracket on the end of the horizontal bar, and can thereby be raised or lowered vertically, or moved horizontally by merely turning one of two wheels on the inching jig. See Figure 1.

Note the adjustable bracket which allows the lower end of the welding head to be swung in an arc, without any appreciable movement of the upper end. This is quite necessary when welding deep buttwelds, in order to gain proper penetration into the side walls of the butt. Work performed, using this inching jig in conjunction with a positioner or any equipment that will turn the job, requires only the removal of the fused flux and the adjustment of the welding head position once in every circumferential weld; it produces a weld with all the efficiency and appearance of a fully automatic submerged-arc weld. In order to facilitate the filling of the welding head flux can, an additional flux can, holding approximately 75 lb of flux, is suspended over the job, with a hose running to the welding head

Figure 1 — The inching jig is an essential part of the welding application.



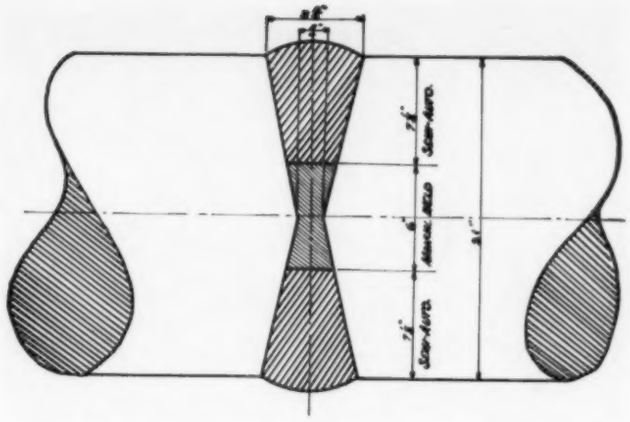


Figure 2 — A 24-in. spindle was reclaimed by welding.

flux can, thus insuring a continuous flow of flux without the necessity of adding flux to the welding head every few minutes.

Most of the work performed at our plant, using the submerged-arc method, is of the "buildup" type, but several types of work requiring buttwelding have been successfully completed, using the "inching jig" in conjunction with lathes or positioners. A very interesting job of this type was the joining of two broken spindles

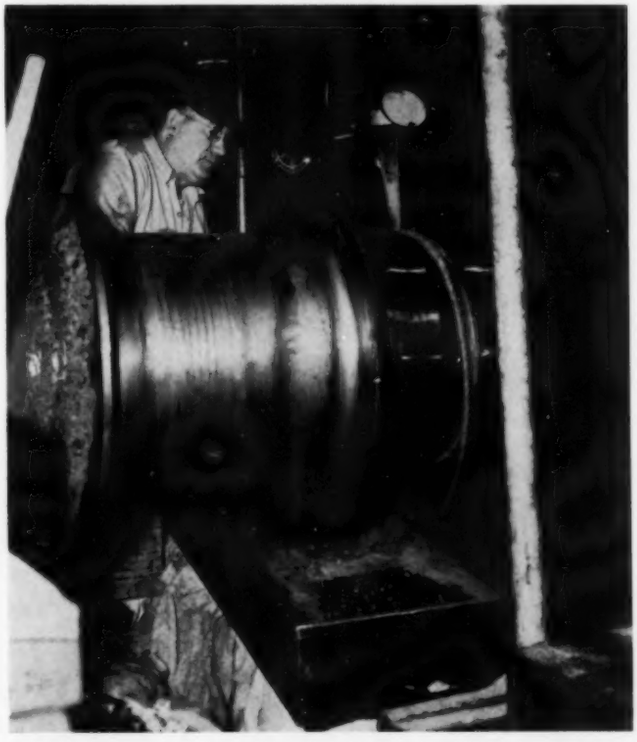


Figure 3 — It was necessary to get good penetration into the side walls.

into one good spindle. The good spade of one spindle and the good shaft of another were removed from two broken spindles, the ends machined and set-up for welding. The ends to be welded were machined to a point, making cone shaped ends and these ends placed in a position that gave a $\frac{3}{4}$-in. opening at the center of the butt and a $3\frac{3}{4}$-in. opening at the outer edge. The shaft was 21-in. in diam. A manual weld, using low hydrogen electrodes, was deposited until the butt was welded to a 7-in. diam. See Figure 2.

The entire job was placed in a lathe and the newly welded deposit was machined back to a 6-in. diam and all slag and spatter removed from the sidewalls of the butt. A semi-automatic welder was set up in conjunction with the inching jig, using a bracket that would swing the welding head horizontally, thereby insuring good penetration into the sidewalls of the butt. The butt was completed using the submerged-arc process, adding approximately $\frac{3}{16}$ in. reinforcement. See Figure 3.

About seven months later a similar job was completed. This shaft was only 18-in. in diam. There were two buttwelds to make, one on each end of the shaft. Due to a higher chemical analysis, this shaft was preheated

Figure 4 — Bore is welded in an upright position.

to 350 F, and this heat maintained throughout all welding procedures. The following measurements resulted when the shaft was set up for welding:

Root opening—$\frac{1}{4}$ in.
Face opening—$3\frac{15}{16}$ in.
Land measurements—$\frac{1}{8}$ in.

The joints were first manually welded to 6-in. diam, one at a time, to control shrinkage. After the manual welds were machined smooth, two semi-automatic welders, using the inching jig, were set up and both joints were welded simultaneously.

Reclamation of sheave wheels by hand welding was a slow process. Rebuilding the two faces and bore

Figure 5 — Rope grooves are completely rebuilt by welding.

required an average of about 30 hours of manual welding. Warpage and distortion prevented all but a minimum of work on the rope grooves. Using a semi-automatic submerged-arc welder and the inching jig, in conjunction with a positioner, the entire job, including the complete rebuilding of the rope grooves, may be finished in about 10 hours. The bore is welded while resting in the vertical position, by allowing the unfused flux to fill the bore as the job progresses up the side of the bore. See Figure 4.

Figure 6 — Baffle plates are welded through the slots.

A quick-changing jig was used to facilitate the changing of the wheel to repair the opposite face. This same setup and method is used to completely rebuild the rope grooves without any warpage or distortion. See Figure 5.

The fabrication of water-cooled valve gates was virtually impossible to perform by manual welding methods, due to warpage and distortion caused by the slow deposition of weld metal and slow distribution of heat. Using the present method, two dished faces are slotted for the reception of baffle plates. The baffle

Figure 7 — Edges are built up to provide a machining surface.

plates are then tacked to the inside of one face and the two dished plates are tacked together. By using a semi-automatic welder, the baffle plates are welded to the two dished plates through the slots. See Figure 6.

The gate is then placed on a positioner and the butt

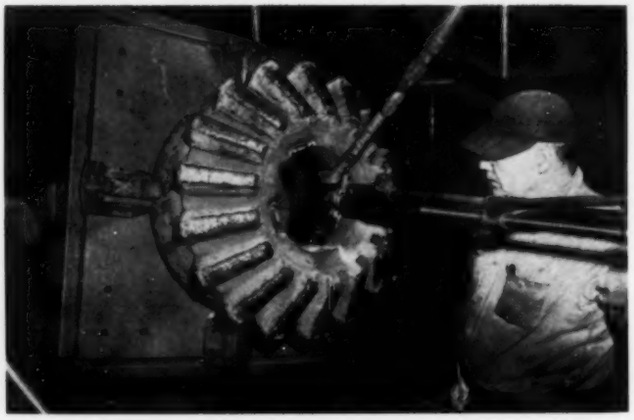


Figure 8 — For small bores, it is necessary to cut the flux cans.

resulting from the fitting of the edges of the two plates is welded.

The gate is then positioned in a flat plane and a portion of the edge is built up to provide a machining surface for a seating ring. See Figure 7.

The finished job presents a true gate, with no warpage, ready for machining.

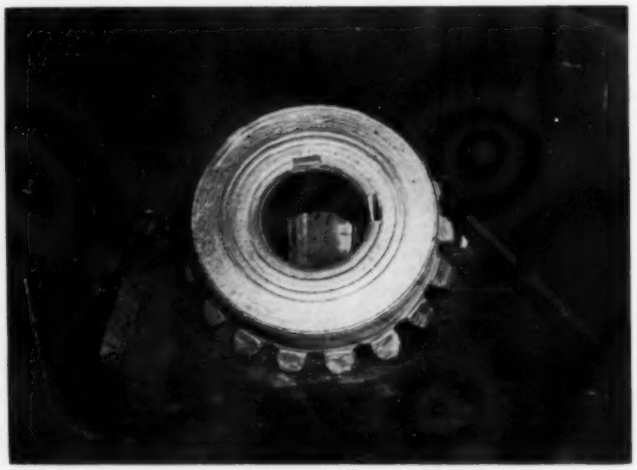


Figure 9 — Small roll gear is rebuilt by welding.

Small bores may be reclaimed using the inching jig and a positioner by first cutting the flux cans on the welding head as short as possible. See Figure 8.

Figure 10 — Side guide plates are welded semi-automatically thus saving time.

Small vertical roll gears are repaired by manually building up the gear teeth, then, after tacking a piece of scrap plate in the keyways, the bore and the wearing face are rebuilt by the semi-automatic submerged-arc process. See Figure 9. Work roll bearing boxes and

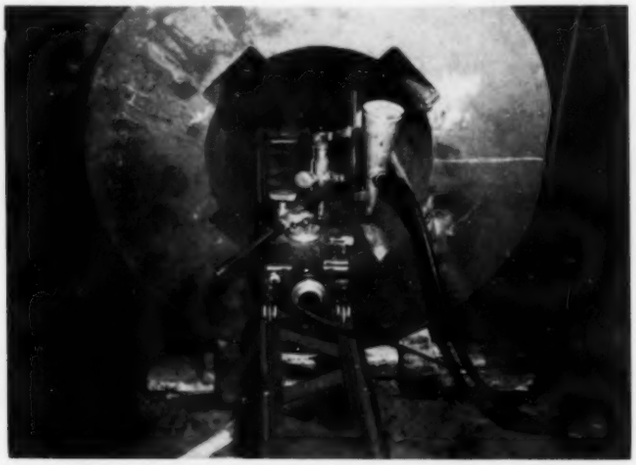


Figure 11 — A radiagraph machine is used for longitudinal welding reclamation.

ingot buggy journal boxes are welded the same way.

Many similar jobs are possible by using this procedure. Side guide plates were formerly welded manually and although four welders worked simultaneously on the job for a total of 32 hours and various procedures of staggered welds were tried, distortion prevented a successful job. Using a semi-automatic submerged-arc-welder this job was completed in 3½ hours, without any apparent distortion or warpage. See Figure 10.

A radiagraphing machine and track, when used in conjunction with a semi-automatic submerged-arc-welding head opens the field of longitudinal welding reclamation. When the keyways of large vertical roll gears are worn beyond the critical point, the radiagraph track is laid inside the gear, with a submerged-arc-

Figure 12 — A radiagraph machine is also used for building up keys.

welding head attached to the radiagraph machine by a special bracket. See Figure 11.

After the alignment is adjusted, it is a simple matter to activate the welding head and radiagraph machine and deposit a good, porosity-free weld. One side of each of the two keyways can be repaired without turning the gear. The same equipment is used for building up the keys that fit in the above mentioned keyways. See Figure 12.

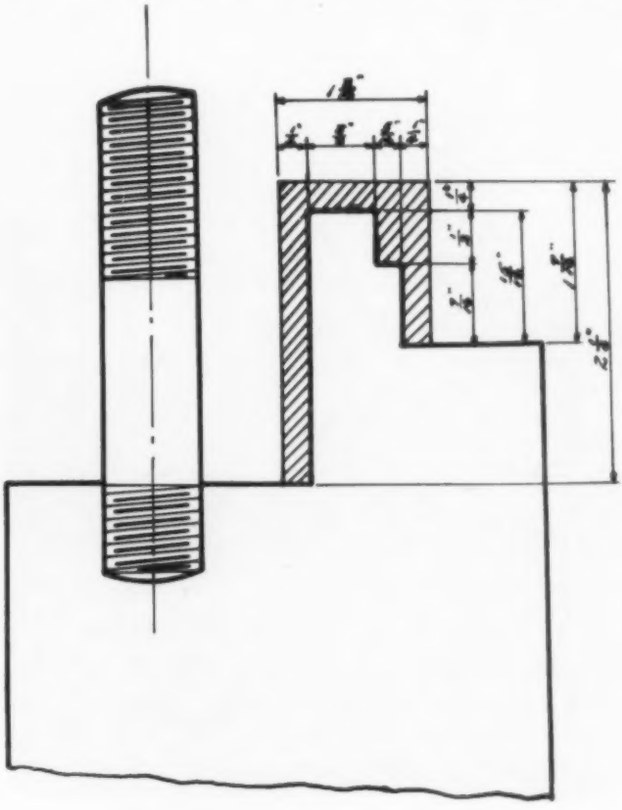
When these keys were welded manually, the time required was 200 hours, using this method, the time required was 40 hours. One of the most repetitious and time-consuming jobs of reclamation is that of repairing gas-engine cylinders and piston bowls and rods. Although the piston rods and bowls have been repaired

Figure 13 — The presence of stud bolts made the welding difficult manually.

by fully automatic processes for years, the work on the gas-engine cylinder was completed by manual welding.

By salvaging a large boring-mill gear that was worn beyond the critical point for accurate machine work, a turn table was fabricated, using a pneumatic machine

Figure 14 — Job can be done without resetting the jig.



for power. The air pressure is used as a controlling factor for rpms. This turn table was built sturdy enough to handle gas-engine cylinder halves.

By using this turn table in conjunction with the inching jig, over 80 per cent of the reclamation welding on gas-engine cylinders is now accomplished by the submerged-arc process. The step ring was difficult to repair manually due to the proximity (1 in.) of the circle of stud bolts. See Figure 13.

Figure 15 — A sheet metal flux dam is used on the inside of the cylinders.

By shaping a flux can and welding head to fit, this job, using the turn table and inching jig, is now completed in approximately 24 hours, instead of the 130 manual hours. The job is free from porosity, and so

Figure 16 — Gas engine cylinders had inside and outside edges rebuilt.

regular is the deposit that little or no touch-up is necessary. By manipulating the inching jig only, the entire job is completed without resetting the job or changing welding equipment. See Figure 14.

The fire-seal joint build-up is deposited on the vertical wall of the cylinder in a seemingly impossible position, by use of a sheet metal flux dam, tacked just below the fire-seal joint, and with the aid of the inching jig and turn table. This produces a non-porous weld and eliminates touch-up time, thus saving tie-up time on a boring mill. Submerged-arc time was 3 hours, manual welding time 10 hours.

The reverse end of the gas-engine cylinder known as the female joint is flat, with cut-out areas for the fitting of keys for the assembly of the halves. In order to present a complete circle of flat surface, small pieces of scrap plate are tacked in these cutout areas. A sheet metal flux dam is tacked to the inside of the cylinder. See Figure 15.

Using the turn table and inching jig, the job is completed and the scrap pieces are burned out and the job is ready for machining.

As it required 80 hr to weld this section manually

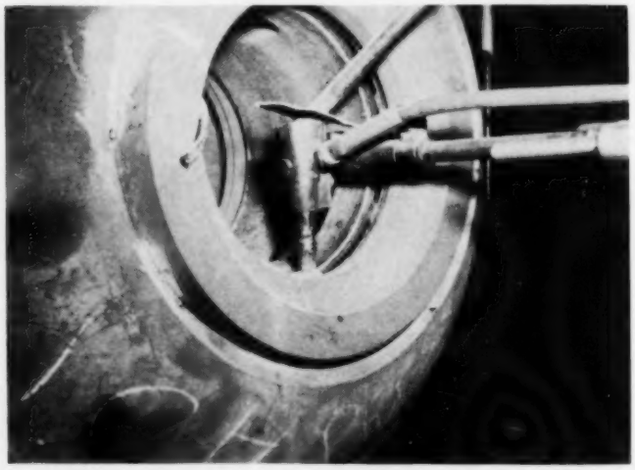


Figure 17 — Repair of ring-groove bowl is shown in figure.

with the cut-out areas, and only 24 hr to build up this job, including the scrap plates and setting up, it is obvious that the wasted weld deposit is more than compensated for.

On each section of the gas-engine cylinder are two large flanges, one on each side. These flanges have 12 and 16 bolt holes, respectively, and it is necessary to build up the inside and outside edges, as well as the face of each flange for machining. Manual welding on both flanges totaled approximately 90 hr. By placing a sheet-metal ring around the outside edge and a sheet-metal plate on the inside of the flanges, to act as flux dams, these flanges are now ready to weld with the submerged-arc process. See Figure 16.

Using the turn table and inching jig with a special bracket these flanges can be welded with the edges of the flanges in a vertical plane. The face of the flanges are welded in the same manner, using the same setup, except the portions between the bolt holes.

The flanges are completed manually and the total time required by this method is 46 hours.

The ring-groove bowls used in gas-engine cylinders sometimes wear or crack in the area immediately ad-

joining the piston rod. This area is cut out and a specially machined insert set in the bowl and welded. This insert is so constructed that two buttwelds are necessary. See Figure 17.

When welded manually, this insert was cut in two pieces and each piece welded inside and outside. Then the two butts formed by the two halves were welded. Even when the bowl was mounted on a positioner, this manual weld consumed 80 to 90 hours. By using the semi-automatic submerged-arc welder, a positioner and the inching jig, the insert is welded as fabricated, i.e.

Figure 18 — It is sometimes advantageous to use two semi-automatic welders on large round jobs.

the insert is not cut in two. The fast deposition of weld metal and the rapid distribution of welding heat cut this time to 20 hours.

This bowl is then welded to the piston rod by the simple expedient of placing the rod on end in a tower-like arrangement. Live steam is used to preheat the area for welding and the buttweld is made by using the

Figure 19 — For odd shapes, special jigs are helpful.

semi-automatic submerged-arc welder in the conventional manner. This job is not repetitious enough to provide a turning arrangement in order to eliminate the hand work.

Large circumferential jobs may be completed much more quickly if two semi-automatic welders are used, located 180 degrees apart. Figure 18 shows a large cable drum being repaired by this method.

Figure 20 — On this bearing housing, the electrode is fed down through top of flux cans.

Overlay deposits can be made on off-center jobs by using special jigs. Exhaust ells mounted on special jigs may be welded quickly and efficiently. See Figure 19.

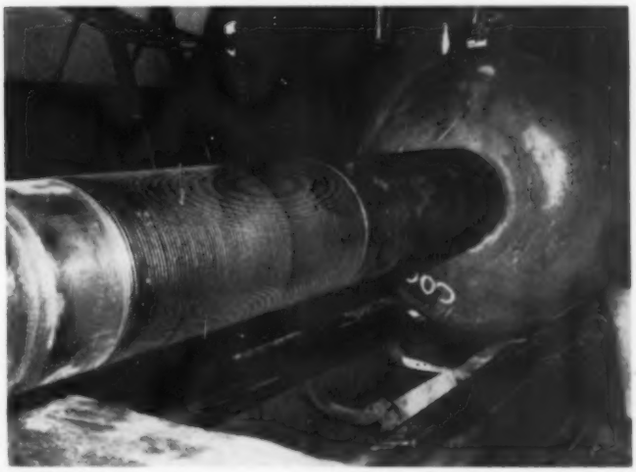
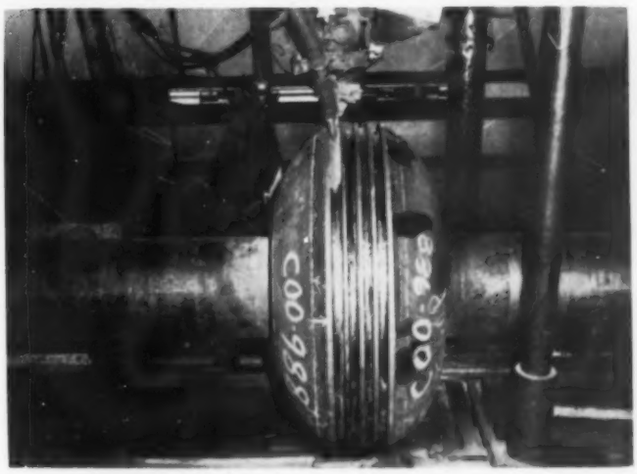


Figure 21 — Piston rod is done with fully automatic equipment.

A large bearing housing necessitated the fabrication of a special jig and rearrangement of the welding head.

Figure 22 — Full automatic equipment is also used on ring-bowl grooves.



The electrode feed was changed from the side of the flux can and so arranged that the electrode would feed down through the top of the can, and a long bracket was fitted from the can to the inching jig. See Figure 20.

By placing the bearing house on the turn table and adjusting the inching jig so the long bracket reaches down to the bottom of the housing, this job was welded from the bottom up, through the counter bore, across the inside face and on up the large bore. Both bores were in the vertical plane.

Considerable work such as piston rods is being done by the fully automatic submerged-arc equipment. See Figure 21.

Gas-engine ring-bowl grooves are also reclaimed by this fully automatic method. See Figure 22.

Table-roll journal ends are renewed by this process, as well as the roll surface. New journal ends are prepared and pressed into a boring at the end of a roll. This preparation results in a butt which is buttwelded. See Figure 23.

Experimentation in hard surfacing, using the submerged-arc methods is under way, but sufficient experience in job-lasting qualities is not available at this time.

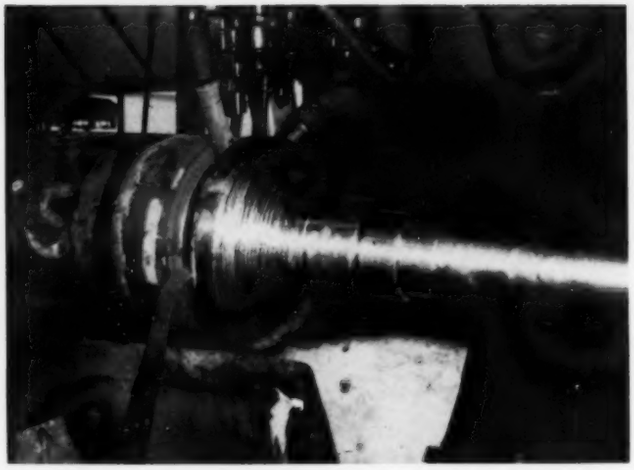


Figure 23 — Process is also used on table-roll journal ends.

NEW DEVELOPMENTS IN LUBRICATION PRACTICE

. . . . constant developments in lubricating equipment are increasing productivity and reducing costs . . . .

By C. M. SCHAEFFER
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▲ THE purpose of this paper is to demonstrate how standard types of lubricating and allied equipment can be applied in order to gain complete automatic control of the various lubricants required throughout a steel mill.

It must be recognized that centralized lubrication as referred to in this paper covers the mechanical delivery of the proper amount of correct lubricant, clean and uncontaminated, to each individual point of consumption throughout the full range of working conditions that may be encountered with each particular installation. Also, that the equipment is lubricated during operation without loss of production time.

We have appreciated the advantages of centralized lubrication for many years and have installed many such systems. With their completion, a general improvement in the equipment serviced was noted in that downtime due to bearing wear and failure was reduced, with a consequent increase in production. All failures, however, were not eliminated, and studies of each failure were made with the hope of finding some solution as to their cause. These studies revealed that only a small percentage of bearing losses was due to mechanical failure of the centralized system, and that a large majority was due to the human element.

It was revealed, that in many cases the operators of the equipment had failed to keep the reservoir filled, or had shut down the lubricating equipment and had failed to restart it. It was also discovered that in many cases the operators did not know how the equipment was supposed to function.

In order to overcome this last difficulty, classes were started to instruct all operators in the proper handling of the lubricating equipment. Demonstration systems were built with valves made of transparent plastics to visually reveal the inside workings of the valves. Although this instruction of the operating personnel gave everyone concerned an intimate knowledge of the lubricating system, our bearing failures still continued to some extent.

Our conclusion was to eliminate the human element as much as possible. With this in mind, the next step was to set up the 35-in. blooming mill with completely automatic lubrication as follows:

1. The mill motor bearings are lubricated with a gravity oil system fed from an overhead tank. The oil leaving the bearings is discharged into a sump located below the floor level of the mill. Oil is then pumped from the sump by a positive displacement pump, passed through a pressure filter and discharged into the overhead tank.

   Two float switches, one slightly above the other, are installed in the overhead tank. Each float switch is used to control a complete pump and filter system. In the event that the lower float switch becomes energized, a lock-in type relay is energized and lights a signal in the sub-station. The sub-station operator immediately reports the trouble to the mechanical department.

   An overflow from the overhead tank to the sump is provided in case of failure of the float switches.
2. The mill pinions and their bearings are lubricated by a pressure-type oil system. Here, a positive displacement pump raises the oil from a sump located below the mill floor, passes it through a pressure-type filter to the pinions and bearings, from where it flows by gravity back to the sump. Here again two complete pumping systems are employed, with the service unit set to operate at 10 psi higher pressure than the reserve unit by means of pressure switches. These systems are energized when the mill motor is cut into service. The reserve pump is held out of service on start-ups by the use of a time-delay relay which allows the service unit sufficient time to build up to operating pressure before permitting the reserve unit to cut into service. In the event the reserve pump is required, a lock-in type relay flashes a light signal to the sub-station operator.
3. The next system lubricates the mill screws, screw-down nuts and screw-down gears. Two measuring pumps are used, each pump having a lubricant line connected directly to one screw-down gear housing. These measuring pumps are of a type that remain under constant air pressure. When the air is momentarily released on the discharge side, the pump makes one stroke. The stroke is adjustable from 0 to 1 pint in capacity. Solenoid-operated air valves are connected to the discharge side of each pump air cylinder. The electric control is accomplished by the use of a single time clock mounted on the main control panel in the central station.

   The lubricant discharges over the screw-down gear teeth at a point where 90 per cent of the lubricant flows across the teeth and into the gear-housing reservoir, while approximately 10 per cent of the lubricant flows to the inside of the gear to lubricate the key of the screw. That portion of the lubricant that goes into the housing reservoir finds its way through oil grooving in the gear thrust into the gear bearing, out the bottom of the bearing housing and on the screw threads and into the nut. This lubricant is retained in the nut by the use of grease to form a seal in the lower section of the nut. The grease is fed from the grease automatic system. The excess lubricant that escapes through the nut continues down the keyway and screw and lubricates the breaker block under the screw.
4. Another system covers all of the grease bearings used in connection with the mill, mill tables, roller lines, side guards, and drives for all tables from the ingot receiving table to the mill shear.

   The unique feature of this system is the method used to keep the system reservoir full. A standard-type air-operated barrel pump is used to transfer the lubricant from the original container to the system reservoir. A solenoid-operated air valve is used to start and stop the transfer pump with the electric control of the solenoid valve mounted on the indicator rod of the grease-system reservoir. As protection against the grease drum becoming empty, a safety flow valve, connected into the air line, automatically shuts off the air when the load decreases on the transfer pump, allowing it to consume additional air. A signal device is also incorporated to show a red light when this occurs.
5. The final full-automatic lubrication system is used to apply a solvent-type gear shield to all open gears connected with this mill. This system uses measuring valves that control the passage of both air and gear shield through a mixing nozzle located at each gear and is so arranged that a measured supply of gear coat is sprayed by use of a minimum amount of compressed air at predetermined intervals during the time the mill is in operation. The timing device for this system is mounted on the main control panel of the central pump room.

The last three systems which are controlled from the main control panel mounted in the central pump room are all started and stopped by having the central control panel cut into service automatically when the main mill-motor circuit breaker is cut into service. Appropriate signal lights are used on all three systems, with blue lights to indicate the systems are in service and red lights to indicate system failures.

The shear for this mill is grease lubricated with a separate full-automatic lubrication system that covers all shear bearings and shear-table bearings. This system is designed to start automatically when the circuit breaker for the shear motor is cut into service.

No attempt has been made to lubricate any electric motor bearings other than the main mill-motor bearings.

Lubrication labor on the mill is confined chiefly to inspection of the various systems, having the different kinds of lubricant available to the systems, and keeping the reservoirs filled to a safe operating level.

All blooming mills and large structural mills use babbitt roll-neck bearings which are lubricated from automatic central stations. One of our most serious problems has been to keep the grease grooves clear and open. This problem has been solved by the use of fabric strips with milled-in grease grooves placed approximately 60 degrees from the bottom center of each side of the bearing. The design of the groove is such that it is practically impossible to get a sharp or wiping edge and it cannot close up. Thus a free flow of lubricant is maintained. The result has been greatly extended bearing life.

In order to improve the life of the thrust ends of

these bearings, three fabric blocks are now imbedded into the thrust collar, one block on bottom center and one block in line with each of the two fabric strips. The grease groove is extended into the thrust block, which assures adequate lubrication of the thrust. All of these improvements have extended the normal life of roll-neck bearings.

In a plant the size of the Bethlehem plant, the consumption of lubricating oils is extremely high. Much of this oil is used to lubricate the large steam engines used as prime movers on the older blooming and shape mills. There are also a large number of machine tools operating at Bethlehem that require frequent oil changes.

Several years ago a machine to reclaim lubricating oil was installed in one of the oil houses. This particular location was chosen, first, because an attendant was already on duty in this oil house, and the operation of the machine could be made a part of his normal duties. Secondly, the oil house was centrally located, in regard to the consuming point of oil that could be reclaimed.

The capacity of the machine was 10 gallons of oil per hour. However, with the necessary work and time required to handle the clean drums, dirty oil drums, and the cleanup required in changing from one type of oil to another, an average of only 1500 gallons of oil per month was reclaimed.

The cost of clays, filter pads, and repairs to the machine averaged 1½¢ per gallon of oil reclaimed, while the average value of the oil is 40¢ per gallon. The operation has resulted in a net saving of slightly over $575.00 per month for the years it has been in service.

Recently a broad program for the reclamation of used lubrication oils for the entire plant has been inaugurated. We have installed an automatic barrel washer plus two additional oil-reclaiming machines along with the necessary tanks. Several automatic labor-saving features have also been added to the reclaiming machines, all of which will permit the same oil house attendant to operate the three units with no more work than formerly required for the one machine.

The new station will have a capacity of 52 gallons per hour, and by the use of automatic controls the efficiency of the station will be considerably higher than that of the former station. The problem of educating the various shop personnel, particularly those in the machine shops, to change oil in their gear cases more frequently and to keep the various oils in separate containers has already been started.

Studies are being made whereby oils that have become so mixed that they are unsatisfactory for further lubrication work will be cleaned and blended with a base emulsifier and used as general-purpose soluble oil throughout the plant.

The foregoing developments are but a few examples of the constant effort being made to keep the lubrication and maintenance costs at a minimum. It has also been established that as these costs are reduced the productivity of the equipment is increased.

DISCUSSION

PRESENTED BY

WILLIAM A. MILLER, Superintendent, Rolling Mills, John A. Roebling Sons Co., Trenton, N. J.

A. E. CICHELLI, Lubrication Engineer, Construction and Engineering Depts., Bethlehem Steel Co., Sparrows Point, Baltimore, Md.

C. M. SCHAEFFER, Lubricating Engineer, Bethlehem Plant, Bethlehem Steel Co., Bethlehem, Pa.

William A. Miller: On the fabric strips you put into your bearings with grooves in for grease — do you have any trouble pouring the babbitt against the fabric strips and does it cause any charring of the edges of the strips?

A. E. Cichelli: Please tell us how much saving your completely automatic system on the 35-in. mill gave you, taking into consideration operating and mechanical delays as well as maintenance costs prior to and after that installation.

C. M. Schaeffer: The fabric strip will take babbitt poured right alongside with no noticeable charring. The fabric strip is anchored in a groove in the bearing and the thrust block is anchored with a pin. We have absolutely no trouble getting the babbitt against the fabric with no apparent shrinkage at that point.

On the 35-in. blooming mill, we operated on block grease before installing the automatic system on the roll necks. The new type bearings, automatic lubrication system, etc., were all installed at the same time. This happened during September of last year. Since that time, we have used the second set of bearings on top and the third set of bottom bearings are now being installed.

Formerly, we had to change bottom bearings every two weeks and top bearings every four weeks. The complete combination has improved our bearing life by five to six times.

I can give a better example on savings due to the new grooving arrangement. We have a larger blooming mill, 46-in., that has been operating on automatic lubrication for many years with grease grooves cut into the babbitt. These grooves would not stay open, for one roll change, or an average of a week or ten days, and had to be rechipped during each roll change. Since using the fabric strip with the grease groove milled into them, we have had no difficulty in keeping the grooves open. Bearing life has increased accordingly.

We have in our entire plant only one mill — it is really a pair of mills, but both do the same work — operating on a brass thrust collar. We have taken all brass out of the babbitt. On our 42-in. mill, where we have only an inch and a quarter thrust area, we had to retain the brass thrust due to the heavy load. This thrust is renewable and has extended this bearing life several times. On all other mills with thrusts of two inches or over, we use the fabric block in combination with the babbitt. We are presently getting ready to test some all fabric thrusts on one of our mills by which we hope to get even better bearing life.

Engineering Applications

FOR CHROMIUM PLATING

By DR. RICHARD WICK
Research Engineer
Bethlehem Steel Co.
Bethlehem, Pa.

. . . . engineering applications of chromium plating have given savings because of increased life and reduced maintenance . . . .

▲ ENGINEERING applications for chromium plating comprise a field useful in maintenance of mill equipment. It is complementary to other methods of surface metal application (spraying or welding) which have particular usefulness in certain cases. Chromium plate for engineering use is applied directly to the steel surface in thickness seldom less than 0.001 in., except for cutting tools. For most engineering applications, finished chromium thickness of 0.006 to 0.015 in. is adequate, and for particular reasons up to 0.100 in. may be used profitably. This contrasts with the decorative chromium plating at ten to twenty millionths inch thickness, over nickel plate.

PHYSICAL PROPERTIES OF CHROMIUM PLATE

Many properties other than the decorative requirements of color and brightness become significant when chromium plate is used for engineering purposes. The full significance of these physical properties is only slowly becoming apparent; it is conclusive that the properties are determined by the method of chromium plating used, and that they often determine the success of industrial applications. Of the physical properties, those affecting wear resistance, load resistance, and the strength of the machine element are important.

The wear resistance afforded by chromium plating is well known. Chromium surfaces characteristically "wear smooth" when working against steel, bronze, babbit, etc., with the result that the opposing member has its life markedly extended. The "anti-galling" or "non-pickup" properties of chromium plate is beneficial in improving wear resistance. The coefficient of friction of chromium against steel is about half that of steel against steel, and similarly for other materials. The hardness of chromium plate is a factor in its wear resistance, but it does not follow that the harder the chromium the greater its resistance to wear; in the hardness range from 400 to 1100 Brinell, optimum wear resistance has been reported to occur at about 800 Brinell. The high corrosion resistance of chromium is significant in determining its resistance to wear, sometimes being the controlling factor in special applications, and a limiting factor in others where the chromium reacts chemically, including oxidation at high temperatures.

The load resistance of chromium plate is a little recognized and imperfectly understood property; there is substantial difference between different types of chromium plating in this regard. A direct quantitative measure of this has not been developed. The base metal hardness must be sufficient to withstand the imposed service stress without permanent deformation, since the chromium plate itself is ineffective in this regard. Likewise, chromium plate adhesion to the base metal must exceed the strength of either metal, in order to give the maximum load resistance. With the requirements of base metal hardness and chromium plating adhesion satisfied, the load resistance then depends on the chromium plate "ductility" or "malleability". This characteristic is qualitatively correlated positively with increase in density and decrease in oxide content of the chromium plate.

The strength of the machine element should properly involve only those factors that might be altered by chromium plating. This is simplified by separating out, as was just done, considerations of the load resistance of the chromium plate, leaving two principal effects.

Hydrogen embrittlement is a possibility on chromium plating hardened steels, much less so with low carbon and alloy steels; it is avoided by low temperature heating (400 — 500F), after chromium plating, in oil or air for one to five hours, depending on the cross-section of the member. This treatment may also be used before chromium plating in cases of extreme susceptibility to embrittlement. The usual practical limit of steel base hardness is taken as Rockwell C57 to C62. Fatigue strength lowering caused by chromium plating correlates with the steel heat treatment. Normalized steel is not significantly affected in fatigue strength by chromium plating, while tempered steel has its fatigue strength lowered by as much as 50 per cent. These results are reproducible, but it must be noted that the heterogeneous chromium/steel composite is tested on the standard rotating fatigue test specimen normally used for homogeneous metals, and that the calculated fatigue strength is based on the base metal (steel) dimensions. In heterogeneous (i.e. chromium plated) systems, the specimen shape factor may be significant, while normally it is of less consequence. It is conservative to use a 2X strength factor in designing high unit strength and fatigue susceptible machine members that are chromium plated; this reduces to unity in many cases involving oil holes, fillets, threads, keyways, etc., on or adjacent to the chromium plated sections involved, since the separate effects are not additive. Corrosion fatigue values are improved by chromium plating, as would be expected.

SPECIFICATIONS FOR CHROMIUM PLATING

Engineering specifications for chromium plating define the area to be plated and the finished thickness of the chromium. Thickness specifications for the chromium plate on working drawings such as for a shaft would define the diameters before and after chromium plating and grinding, with the pertinent tolerances. From this is readily obtained the minimum and maximum thickness of chromium plate, the average of which is the nominal thickness specification.

Care must be taken in grinding to avoid eccentricity, encountered especially when different machines are used to grind the steel before plating and the chromium after plating, since the uniformity of coating thickness is distributed by the amount of the eccentricity. An allowance for additional chromium thickness over that specified is made for grinding in the plating department, or specified for outside work, and usually ranges from 0.0015 in. to 0.005 in., depending on the size of the unit, the number of pieces plated, and the coordination between the plating and finishing departments.

The chromium plated member may be plated to size in some cases; here, the thickness is specified on the low side, from 0.001 to 0.005 in. A light "polishing" operation is sometimes resorted to. This tends to avoid the hazard of occasional random surface irregularities that could cause difficulty in initial service operation. Chromium plate may be "inlaid" on new parts by providing for the removal of a few thousandths of an inch of steel adjacent to the chromium plated area at the end of the final grinding step. Specifications should not require that the chromium plate be applied at full thickness up to the face of a larger diameter section. It is possible to do so at some expense, but is usually not necessary.

PRODUCTION OF CHROMIUM PLATED MACHINE ELEMENTS

The present conventional electroplating process for chromium plating was the first commercially successful method. It is due to Dr. C. G. Fink and its practical use dates from about 1925. Dr. W. Blum and his coworkers, M. Udy, Prof. D. T. Ewing, Dr. R. Schneidewind and others early made significant contributions to chromium plating processes. While most extensively used for decorative plating, the conventional process was also applied to engineering uses. This process in practice used a current density of from 70 to 450 amp per sq ft, at temperatures from 104 to 140F, obtaining an efficiency averaging 12 per cent. The chromium plating bath comprises chromic acid (250 to 400 grams per liter) and sulphate radical (SO_4) to maintain a weight ratio of CrO_3 to SO_4 of 100 to 1. The plating time at 12 per cent efficiency for each 0.001 in. thickness of chromium varies from about 6 hours at 70 amp per sq ft to ¾ to 1 hour at 450 amp per sq ft.

Because of this drawback of low plating speeds, the writer developed a high-speed chromium plating process operable at very high current densities, 1000 to 3000 amp per sq ft being commonly used. The efficiency averages about 18 per cent and varies only slightly with current density, thus giving superior throwing power. This efficiency is about 1½ times that of the conventional process. Thus there are achievable plating speeds in regular practice of from 0.0035 to 0.010 in. per hour. The purpose of this development was simply to broaden the range of plating speed so that more suitable and economic conditions could be selected when desired for particular jobs. The economies that are thus obtained derive from fewer tanks and their controls, smaller floor space required, improved generator utilization, proportionately fewer, though heavier, anodes and fixtures, etc. It was found early in the course of service testing that the quality of chromium plate obtained was significantly improved and more suitable to engineering use than that of the conventional process.

Cleaning prior to plating is important in all electroplating processes. Especially important also in plating thick chromium deposits is the etching of the surface just prior to plating. Correct electrolytic etching is the determining factor in obtaining perfect adhesion, and its importance cannot be overemphasized. Besides adhesion, this etching causes a smoother and more uniform surface texture of the thick chromium plate than otherwise would be obtainable. Heat treatment in oil at about 400F is used after plating.

CHROMIUM PLATING IN MAINTENANCE

The reclamation of worn parts was one of the first applications of chromium plating for engineering use. As experience developed, the rebuilding of complete machines was successfully undertaken. The chromium

plated components were observed to perform so much better than the original that chromium plating is now frequently specified on the applicable parts of new machines; this may be taken as the ultimate criterion of the successful application of industrial chromium plating. It has been found that by chromium plating a steel member, better results at lower cost were obtainable than through the previous customary use of bronze or expensive alloys as the construction material. Once a chromium plated wearing member of a machine has served its useful life, the chromium can be stripped off without removing any of the steel base, after which the part can be re-chromium plated; this sequence can be repeated, with substantial economic benefit.

Chromium plating has proved itself a maintenance tool by the economies that develop consequent to its use. The increase in service life of a machine member before wear reaches the tolerance limit, and the decreased wear obtained on the mating member, are primary factors in reducing cost. The corrosion resistance imparted by chromium plating sometimes results in a lower initial cost for chromium plated steel than for the particular alloys otherwise required. Machine parts operating in packing glands have been found to be benefited by chromium plating in several ways: *a.* the extension of the useful life of the packing material has been known to result in sufficient savings in material cost to more than pay for the cost of the chromium plating; *b.* the extension of the time interval between maintenance adjustments has reduced machine downtime with benefit to production; and *c.* the consequent reduction in the maintenance man-hours required is a readily computed direct cost saving. The rectification of mis-machining errors from whatever cause is a service rendered by chromium plating applicable both to maintenance and to production.

A mere listing of the individual and particular machine parts benefited by chromium plating for maintenance would involve practically every part subject to frictional wear, plus many others subject to corrosion. In this short survey, a few selected applications are discussed.

Pumps — Hydraulic pump shafts and plungers are benefited greatly by chromium plating; a typical example from service test data on a booster pump plunger assembly shows a change in the frequency of tightening of the packing gland from once a shift to once a month, and the packing replacement requirement was extended from once a week to more than five months between replacement. Valves are plated on the seats and stems with benefit; high pressure hydraulic valves and steam valves are improved to the extent that wire drawing is virtually eliminated. The application of chromium plating to the cylinders of pitch pumps is a development credited to the Lackawanna plant of the Bethlehem Steel Company, where service life of these pumps handling high temperature molten pitch containing sulphur was improved by chromium plating the cylinder sleeves and stellite coating the cast iron pistons.

Gas Engines — Extensive service tests on very large chromium plated gas engine piston rods, in comparison with other coating types, was conclusive in demonstrating the savings, both direct and indirect, that result from this application. A minimum of 0.015 in. thickness of chromium is applied to the piston rod.

Steam Engines and Diesels — Chromium is applied to stationary steam engine wearing parts, including valves. Similarly valve and bearing surfaces of the diesel engines in yard engines are chromium plated, including new parts as acquired for replacement.

Coke Conveyor System—The return idler rollers in the coke conveyor system at the end of their first year of service testing show practically no signs of wear, while the standard rollers, installed at the same time for comparison, have been replaced.

Open Hearth Crane Axles — Crane wheel axles in open hearth cranes are subject to severe abrasive conditions; regular axles have an average life of four months in the test area and require two sets of bronze bearings during this time. On chromium plating the axles, after 35 months they are still in service and have worn smooth, while the bearing life has been extended to more than a year.

Gages and Tools — The benefits of chromium plating plug gages are well known. Many thread gages of all sizes have been reclaimed, in some cases after mismachining a finished thickness of 0.075 in. was applied. The life and accuracy of the chromium plated gages are improved. Cutting tools are chromium plated with only a light coating, usually less than 0.0002 in. thick; this application is successful within limits, where the chip bearing load is not excessive, as for finishing cuts. Individual cases should be service tested in order to determine the benefits of chromium plating, which has afforded a two to four fold increase in useful continuous service life.

Pressed Fit Members — Although a minor application, it may be interesting to note that pressed fit members, where the shaft was scored on disassembly, have been reclaimed successfully by grinding out the scored areas and chromium plating back to size. The parts could then be assembled and disassembled several times without failure in the cases studied.

Rams and Plungers — A service test of over five years duration (68 months) was made with a chromium plated ram on a 500-ton forging press. When it was removed from continuous service for use as a spare, it was in fairly good condition and still giving satisfactory service. The 2,093 days of service for this chromium plated ram compares with 474 days which is the best previous record on this press for the usual cast iron ram. The records on the cast iron rams showed an average requirement of 2¼ packings per month, or 153 packings in a 68-month period, which compares to the 25 packings actually used during the test with the chromium plating ram. The 128 leathers saved represent a total reduction of $2,688 in the cost of packings alone, over the test period.

It is evident that the service testing of applications of chromium plating for maintenance is a long drawn out and tedious procedure, for which the operating departments deserve full credit and thanks in appreciation of their sustained interest. A complete economic analysis of the benefits of chromium plating in maintenance practice would involve a difficult evaluation of savings derived from increased machine output, and the like. It is fortunate, as well as significant, that the analyses do not need to include other than the direct savings afforded to demonstrate the substantial benefit derived from engineering applications of chromium plating.

METALLIZING AND ITS FUNCTIONS

. . . . worn surfaces may be built up by metallizing with any metal except chromium, without warpage or distortion of the base material . . . .

By B. SIMON
Metallizing Co. of Buffalo
Buffalo, N. Y.

▲ METALLIZING is a rebuilding and production line process which saves material, time and replacement costs in the following fields.

Corrosion — Structural products of all kinds may be protected by metallizing inside and out against atmospheric corrosion or chemical reaction, as a maintenance economy. In manufacturing, new applications are being found daily for this cost-saving method of corrosion protection.

Rebuilding worn parts — Restoring to better than original performance standards of worn shafts, bearings, cylinders and hundreds of other machine parts, providing definite improvement in wearing and lubricating qualities, is one of industry's major uses of metallizing in machine maintenance.

Mis-machining — Metallizing is used in both maintenance and manufacturing operations for reclaiming thousands of mis-machined castings and machine parts which, except for metallizing's ability to build metal on metal, would fail to pass standard inspection requirements.

Metallizing is still the answer to many maintenance and possible production problems. When metallizing was introduced twenty-five years ago, it was used primarily for decorative purposes and for protecting steel surfaces against corrosion. The first jobs are still in Los Angeles for anyone to inspect. The steel lighting poles on Wilshire Boulevard were metallized with 0.004 in. zinc and 0.010 in. of bronze. The bronze coating was then chemically oxidized to provide a beautiful antique bronze finish. The Wilshire Professional building front, The C. H. Baker Shoe store front, and the elevator casings of the C. C. Chapman Building to mention a few, were metallized with bronze for a decorative finish.

The Southern Counties Gas Co. gas holders at Monrovia, California, and sections of their pipe line to San Diego were metallized with 0.010 in. of zinc. The water tower at River head, Long Island, the water tower on the Washburn Crosby plant at Buffalo, the water tower at Kansas City, Missouri, were metallized with 0.010 in. of zinc in 1932. The coatings are still perfect.

Many of the improvements are the result of suggestions offered by thousands of gun users, and the increasing and widespread use of the metallizing process can be attributed to their cooperation. One of the first guns built for the metallizer, is still in service at Yorktown, Texas. The first gun for jobbing shop practice in 1932 was sold to the Schroeder Welding Co. in St. Louis, Mo. Little was realized at the time that metallizing would reach such an important place in industry in a comparatively few years. In this paper, we want to tell you briefly what it will do, about the improvements in the equipment, the newer methods of preparation, and how to use the process. In the early days the metallizing process was more or less limited to the application of decorative and corrosion resistant coatings but it was not long before it was found that metallizing was as much or even more valuable in the mechanical fields, and it was this discovery that established the process as most important to the maintenance departments of large and small plants and also as a profitable added revenue for the machine and welding shops.

A metallized coating is applied by means of a so-called metallizing gun which is a self contained device consisting of two essential assemblies: the power unit which feeds the wire at a constant selected speed through the combustion unit where it is reduced to a molten state in a reducing flame.

As fast as the wire is melted, a concentric air blast atomizes and projects the molten metal against the surface that is being coated. The fine particles of metal strike the surface at machine gun bullet speed and drive themselves into any fissures that may be in their path, thereby forming a coherent coating. Inasmuch as this is a continuous operation, the metal sprayed coating is quickly built up to any desired thickness. The melting temperature of the flame is approximately 6300F, but due to the air flow around the parts adjacent to the flame, they are little affected by the heat and in consequence have long service life. The coatings from the guns are of extremely fine texture, very dense and carry a minimum of oxide due to the patented baffle used in the spray guns. The metallizing process as a whole involves three phases; first a surface preparation; second, applications of a coating; and third, finishing of a sprayed surface if necessary.

All metallic and in some cases non-metallic surfaces require a preliminary preparation before the coating can be applied. The reason for this preparation is not only to clean the surface, but to roughen it as well so the coating will adhere as it is sprayed on. Many fail to realize that a metallizing bond is purely mechanical and in no way does fusion take place. For this reason it is imperative that fissures be developed on the surface, so the sprayed particles in their molten state can enter and bond themselves into and on the surface when they strike.

Sand blasting — For many years this has been the old standby for surface preparation, but unfortunately the industry has used the word "sand-blasting" in a broad sense, and many failures have occurred because the type of sand used was unsuited for the purpose. What is required is a hard, sharp, angular sand of about 16 mesh, backed up by ample air pressure to prepare a surface to receive a metal sprayed coating.

Sand is generally used for tank or similar flat work but many use it for shaft preparation as well, such as the General Metallizing Co. of Houston, Texas, who have been using Joplin chat for fifteen years without failure. A No. 20 or No. 30 sharp sand will produce an excellent bond for zinc, lead, tin and aluminum. Round sands and soft sands are useless.

Grit blasting — For tank blasting a No. 40 angular steel grit will be entirely satisfactory. For shafting and the like we recommend No. 15 angular steel grit with 100 psi air pressure, this combination giving a splendid bond where blasting is indicated. Today about twenty per cent of our equipment users when preparing a shaft, roll or chankshaft, use a small air chisel to nick the surface previous to blasting. When working on a roll, in addition to blasting, they often use an electric bonder to lay or bead a spongy coating of metal along the edge of the roll. This spongy nickel which is fused into the roll, shows, under a glass, numerous rough pores which provide anchorage for the sprayed metal.

Rough threading — A large percentage of the equipment users prefer this method of preparing cylindrical surfaces, and it is the development of this type of preparation that is largely responsible for the advancement that has been made in the successful coating of machine element parts. At one time there were some questionable patents covering the rough threading of shafts preparatory to metallizing, but after considerable litigation, we were successful in having the patents declared invalid so that all equipment users could take advantage of this advanced method of preparation. Now rough threading as a means of preparation will only be successful if it is properly done. The threading tool must be correctly ground and set in certain relation to the surface being worked on so it tears a thread instead of cutting one.

A satisfactory rough thread will provide innumerable small fissures in the side of the thread, and the top of the thread will have a shredded appearance. Rough threading alone is not always the complete answer to a successful machine element preparation. Quite often parts that are to be metallized will have seen service in a bath of oil, chemical, ink or some other medium that will penetrate into the base. In such a case it will be necessary to heat the part so as to drive the oily substance to the surface where it can be removed. In some cases, even this is insufficient and the part will have to be degreased after heating and before the threading operation. Ninety percent of the failures can be directly traced to lack of understanding or carelessness.

Preparing hard surfaces — Any qualified mechanic will know by simple tests if the base material is too hard to prepare by blasting or rough threading, and if so, he still has the choice of two methods that can be successfully used. The electric bonder which is a low voltage, high amperage transformer, when used in conjunction with the air cooled electrode holder and nickel rod, supplies one means of providing a suitable bond for a metal sprayed coating. The air stream as it flows through the holder keeps the base material cool, and the nickel rod as it contacts the work applies little dots of very spongy material that provide an excellent anchorage surface. This method has been widely used since the company spent large amounts of money having the patents on this bonding method with nickel rod declared invalid. The use of spray bond offers another means of securing a good bond for a metal sprayed coating. Melting at 4500F and striking the surface at close to this temperature, the sprayed metal adheres to the base material and provides myriads of keyfasts over the sprayed area.

Used as a bonding agent, it is only necessary to spray on a coating 0.002 in. thick. When a small build up on a shaft is required, not to exceed 0.030 in. on a side, no extensive preparation is necessary. The shaft may be rough ground or roughened and cleaned with No. 60 emery cloth after which the spray bond F can be sprayed on to be followed by the sprayed coating, but as before stated, not to exceed 0.030 in. on a side with a bonding preparation such as this. It is also used as a supplementary bond on surfaces that have been blasted or rough threaded, when there is some question as to how well the surface has been prepared. In this case 0.002 in. sprayed over the doubtful area will give assurance of a satisfactory bond. Spray bond F can be used, without surface preparation on shafts where it is desired to increase the diameter from 0.002 to 0.008 in. for press fits. It is also used extensively by foundries that have small surface defects in their iron and steel castings which they wish to fill up without blast preparation.

Hard surfacing — For twenty-five years there has been a demand for a hard surfacing material that could be applied with a metal spray gun and stand up under shock with the assurance there would be no breakdown of the bond. There has been developed a method, through a combination of spraying and welding whereby this can be accomplished with uniformly good results. We refer to a very hard material, 3 to 12 times harder than any of the steels, and more corrosion resistant. The procedure is quite simple. After the coating is applied it is only necessary to use a welding torch or a furnace to fuse the sprayed metal to the base.

Following are a few metallizing fundamentals. Worn surfaces can be built up with any metal except chromium, which is not available in wire form. There is not sufficient heat generated during the spraying process to cause warpage or distortion of the base material. As compared to other methods of applying a coating, the thickness can be held to comparatively close limits which reduces the finishing costs materially. Practically all the nonferrous metals are machinable, as are the low carbon steels and No. 1 stainless (18-8). The high carbon steels must be ground and this applies also to No. 2 high chrome and tufton steel.

With twenty-five years of background, we know that a properly prepared and sprayed shaft will outwear and outlast three new shafts. This is due to the characteristic of sprayed metal which retains lubricant better than unsprayed shafts. It is also possible to increase the service life of a shaft by spraying the bearing areas with a suitable wear resistant metal.

Program

1952 AISE CONVENTION

and

IRON AND STEEL EXPOSITION

CLEVELAND PUBLIC AUDITORIUM

CLEVELAND, OHIO

Tuesday, September 30

9:00 am—REGISTRATION—Main Lobby

9:15 am—BUSINESS MEETING—Ball Room

Conducted by President I. N. Tull

9:30 am—ELECTRICAL SESSION—Ball Room

Chairmen: A. J. F. MacQueen, Electrical Superintendent, Algoma Steel Corp., Ltd., Sault Ste. Marie, Ontario, Canada.
W. J. Tunny, Superintendent, Electrical Maintenance, Youngstown Sheet & Tube Co., East Chicago, Ind.

"Air Filters Applied to Cooling Systems of Electrical Rotating Equipment," by Fred C. Reutenauer, Design Engineer, Elliott Co., Ridgway, Pa.

"Transformer Oils for Modern Industry," by Andrew S. Morrow, Staff Engineer, Lubricants Department, Shell Oil Co., New York, N. Y.

"A Simplified Automatic Ingot Buggy," by I. N. Tull, Electrical Superintendent, Republic Steel Corp., Cleveland, Ohio, and Hugh S. Fegely, Control Engineer, Westinghouse Electric Corp., Buffalo, N. Y.

2:00 pm—MECHANICAL SESSION—Ball Room

Chairmen: J. A. Bell, Chief Engineer, Bethlehem Steel Co., Bethlehem, Pa.
F. E. Robinson, Assistant Division Engineer, American Steel and Wire Division, United States Steel Co., Cleveland, Ohio.

"Chromium Plating as Used in the Iron and Steel Mills," by John B. Allen and Jerome D. Tulloch, Chromium Corp. of America, Chicago, Ill.

"Material Maintenance Program," by J. B. Whitlock, General Maintenance Engineer, and J. E. Anderson, Research Engineer, Armco Steel Corp., Middletown, Ohio.

"New Developments in Submerged Melt Welding for Steel Mill Maintenance," by D. E. Knight, Development Engineer, Linde Air Products Co., Newark, N. J.

2:00 pm—COMBUSTION SESSION—Club Room B

Chairmen: E T. W. Bailey, Chief Combustion Engineer, Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada.
R. A. Lambert, Superintendent, Steam and Combustion, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

"A New High Temperature Alloy," by M. N. Ornitz, Works Manager, and R. H. English, Chief Metallurgist, National Alloy Steel Division of Blaw-Knox Co., Blawnox, Pa.

"Experiences with Oxygen Control in Open Hearth Flue Gases," by F. P. Hubbell, Superintendent Fuel Department, Homestead Works, United States Steel Co., Munhall, Pa.

"Application of Automatic Combustion Controls to A New Open Hearth Shop," by F. S. Swaney, Combustion Engineer, Pittsburgh Works, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

10:00 pm—President's Dance—Euclid Ball Room, Hotel Statler

Wednesday, October 1

9:00 am—ELECTRICAL SESSION—Ball Room

Chairmen: Eric L. Anderson, Superintendent Electrical Department, Bethlehem Steel Co., Johnstown, Pa.
F. H. Wickline, Electrical Engineer, National Tube Divison, United States Steel Co., Pittsburgh, Pa.

"The Magnetic Amplifier and its Application in the Steel Industry," by W. E. Miller, Manager, Steel Mill Section, Industrial Engineering Department, General Electric Co., Schenectady, N. Y.

"The Meaning of Commutator Film," by Leon D. Cook, Supervisor Substations, Commonwealth Edison Co., Chicago, Ill.

"Synchronous Motor Torque Requirements for Steel Mill Applications," by Dr. William A. Thomas, Electrical Engineering Manager, The Electric Products Co., Cleveland, Ohio.

9:00 am—COMBUSTION SESSION—Club Room B

Chairmen: A. F. Kritscher, Development Engineer, National Tube Div., United States Steel Co., Pittsburgh, Pa.
G. J. Gockstetter, District Combustion Engineer, Republic Steel Corp., Chicago, Ill.

"Wide Range Metering of Oxygen in Steel Plants," by M. S. Gare, Manager, Ring Balance Division, Hagan Corp., Pittsburgh, Pa.

"Continuous Process Produces High Strength Oil Well Casing by Quenching and Tempering Carbon Steel," by F. H. Bremmer, Chief Combustion Engineer, and F. J. Zehnder, Project Engineer, Spang-Chalfant, Division of The National Supply Co., Ambridge, Pa.

"Castable Refractories in the Steel Mill," by J. D. McCullough, Chief Engineer, Refractories Division, The Babcock & Wilcox Co., New York, N. Y.

2:00 pm—BLAST FURNACE SESSION—Ball Room

Chairmen: C. G. Hogberg, Assistant to Chairman, Blast Furnace Committee, United States Steel Co. of Delaware, Pittsburgh, Pa.
W. H. Collison, Assistant General Superintendent, Furnace Division, Great Lakes Steel Corp., Ecorse, Detroit, Mich.

"Injection of Natural Gas and Oxygen into the Blast Furnace," by Dr. Julien O. Raick, Ingenieur Civil des Mines A. I. Lg. Brussels, Belgium, and James E. Brassert, Vice President, H. A. Brassert & Co., Inc., New York, N. Y.

"Exploration and Development of a New Iron Mine," by R. P. Bremner, Assistant to Vice President Charge of Operations, Youngstown Sheet & Tube Co., Youngstown, Ohio.

"Material Handling Layout of Blast Furnace and Coke Plant at Fairless Works," by Carleton Lord, Materials Handling Engineer, United States Steel Co., Pittsburgh, Pa.

2:00 pm—LUBRICATION SESSION—Club Room B

Chairmen: Robert A. Kraus, Assistant Maintenance Superintendent, Republic Steel Corp., Chicago, Ill.
N. I. Whiteley, Lubrication Engineer, American Steel & Wire Division, United States Steel Co., Cleveland, Ohio.

"Lubricants for Drawing Metals," by Allen A. Brown, Reilly-Whiteman-Walton Co., Conshohocken, Pa.

"The Functioning of a Lubrication Organization in Heavy Rolling Mills," by Robert R. Taylor, Division Engineer, Maintenance and Lubrication, United States Steel Co., Gary, Ind.

"Replacements for Palm Oil in Cold Rolling Steel," by Robert C. Williams, Director of Research, The Ironsides Co., Columbus, Ohio.

6:00 pm—OLD TIMERS DINNER—Euclid Ball Room—Hotel Statler

Thursday, October 2

9:00 am—OPERATING PRACTICE SESSION—Ball Room

Chairmen: Emil Kern, Vice President in Charge of Engineering, Allegheny Ludlum Steel Corp., Brackenridge, Pa.
F. M. Darner, Chief Engineer, Manufacturing Division, Republic Steel Corp., Cleveland, Ohio.

"Processing Properties and Applications for Cold Finished Steel Bars," by J. F. Byers, Metallurgist Bar Products, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

"The Extrusion of Steel, Equipment, Operation, and Production," by Jacques Sejournet, General Manager, Comptoir Industriel D'Etirage Et Profilage De Metaux, Paris, France.

"A Machine to Cold Reduce 18-in. Tubing," by Graham B. Brown, Administrative Assistant, Tube Reducing Corp., Wallington, N. J.

9:00 am—LUBRICATION SESSION—Club Room B

Chairmen: D. E. Whitehead, General Lubrication Engineer, Crucible Steel Co. of America, Pittsburgh, Pa.
Charles A. Bailey, Lubrication Engineer, National Tube Division, United States Steel Co., Pittsburgh, Pa.

"Oil Mist Lubrication for Industrial Machinery," by E. Ralph Harris, Alemite Division, Stewart-Warner Corp., Chicago, Ill.

"The Effect of the Lubricant on Gear Performance," by V. N. Borsoff, Research Engineer, and S. S. Sorem, Research Engineer, Shell Development Co., Emeryville, Calif.

"Considerations in the Design of Plain Bearings," by A. E. Cichelli, Lubrication Engineer, Bethlehem Steel Co., Bethlehem, Pa.

7:00 pm—FORMAL DINNER AND DANCE—Grand Ball Room—Hotel Statler

Friday, October 3

9:00 am—OPERATING PRACTICE SESSION—Ball Room

Chairmen: T. M. Fairchild, Assistant to the General Manager, Bethlehem Steel Co., Johnstown, Pa.
Paul E. Thomas, Assistant to General Superintendent, United States Steel Co., Gary, Ind.

"Applications of the Radiation Gauging Method in the Steel Industry," by George B. Foster, Technical Director, Industrial Nucleonics Corp., Columbus, Ohio.

"The Recovery of Tin from Scrap Tinplate," by A. J. Krombholz, Assistant Head, Chemical Development and Research Division, Weirton Steel Co., Weirton, West Va.

"Dynamic Painting in Steel Plants," by Joseph K. Seyler, Superintendent, Hazelwood Cold Finishing Department, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

9:00 am—ROLLING MILL SESSION—Club Room B

Chairmen: D. W. Lloyd, General Superintendent, Youngstown Sheet & Tube Co., Youngstown, Ohio.
George L. Pimlott, Assistant Superintendent of Bar Mills, Republic Steel Corp., Cleveland, Ohio

"Mechanized Hot Scarfing," by J. H. Zimmerman, Manager, Development and Process Service, Linde Air Products Co., New York, N. Y.

"Aluminum Foil and Its Uses," by W. B. Hackett, Assistant to President in Charge Engineering, Lewis Foundry and Machine Division, Blaw-Knox Co., Groveton, Pa.

"High Speed Mills and Their Application to Ferrous and Non-ferrous Rolling," by George Perrault, Jr., E. W. Bliss Co., Salem, Ohio.

2:00 pm—ELECTRICAL SESSION—Ball Room

Chairmen: K. L. Johannsen, Division Superintendent, Maintenance and Utilities, United States Steel Co., Fairless Works, Morrisville, Pa.
L. V. Black, Superintendent, Electrical Department, Bethlehem Steel Co., Bethlehem, Pa.

"The Adjustable Voltage Ore Bridge Drive at Otis Works," by Clark B. Risler, Industry Engineer, Westinghouse Electric Corp., East Pittsburgh, Pa., and E. C. Juhnke, Electrical Engineer, Otis Works, Jones & Laughlin Steel Corp., Cleveland, Ohio.

"Modern Lighting Systems for Steel Mills," by R. F. VandenBoom, Illuminating Engineer, General Electric Co., Cleveland, Ohio, and D. L. Beeman, Manager, Industrial Power Engineering, Industrial Engineering Department, General Electric Co., Schenectady, N. Y.

"Protection of Underground Cable Sheaths," by T. W. Alexander, Jr., Transmission Engineer, The Bell Telephone Co. of Pennsylvania, Pittsburgh, Pa.

2:00 pm—COMBUSTION SESSION—Club Room B

Chairmen: F. Bruce Bevelheimer, Power and Fuel Engineer, Steel Division, Ford Motor Co., Dearborn, Mich.
George H. Krapf, Chairman, Fuel and Power Committees, United States Steel Co., Pittsburgh, Pa.

"Safe Handling of Fuels, Hazardous Gases and Liquids," by F. R. Pullen, Fuel Engineer, Bethlehem Steel Co., Johnstown, Pa.

"The Characteristics of Fuel Oils Used in the Steel Industry," by John P. Critchlow, Chief Fuels and Lubricants Engineer, Rolling Mill Section, Gulf Oil Corp., Pittsburgh, Pa.

"The Pumping and Burning of Tar and Pitch," by Warren A. Pond, Manager of Industrial Viscous Fluid Department, Fluid Systems, Inc., New Haven, Conn.

EXPOSITION AND TECHNICAL SESSIONS are at Cleveland Public Auditorium.

SOCIAL FUNCTIONS are at Hotel Statler.

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Iron and Steel Exposition Hours

September 30 — Tuesday,	10:00 am - 10:00 pm
October 1 — Wednesday,	10:00 am - 10:00 pm
October 2 — Thursday,	10:00 am - 5:30 pm
October 3 — Friday,	10:00 am - 4:00 pm

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NO REGISTRATION FEE

IRON and STEEL EXPOSITION

CLEVELAND

September 30, October 1, 2, 3

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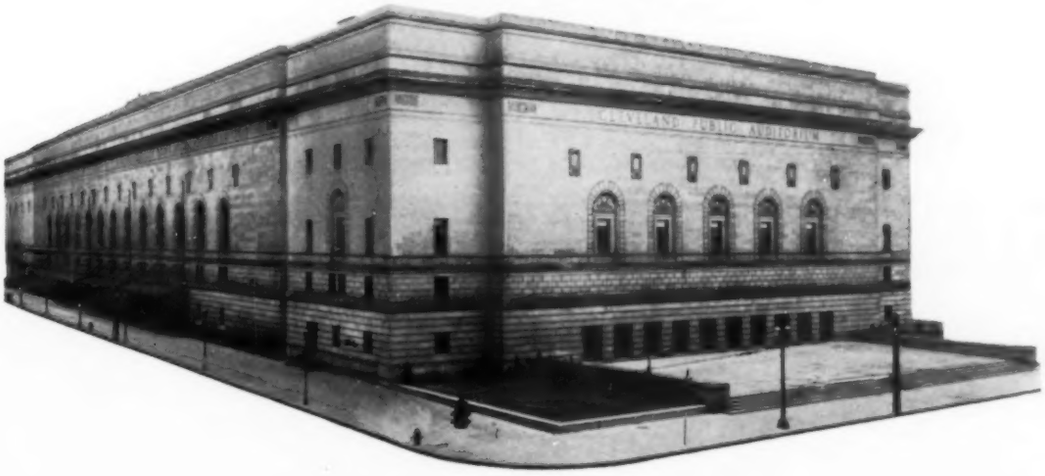
IRON AND STEEL EXPOSITION
CLEVELAND PUBLIC AUDITORIUM
CLEVELAND, OHIO



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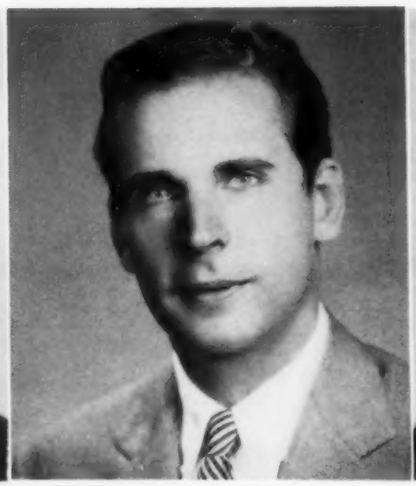

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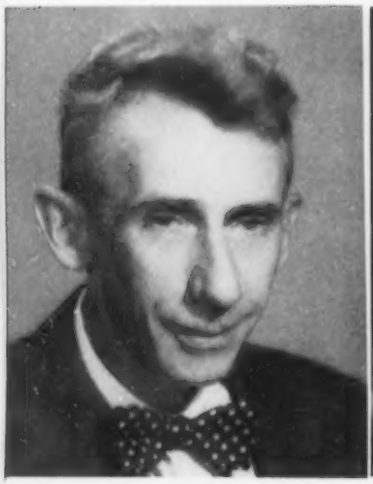

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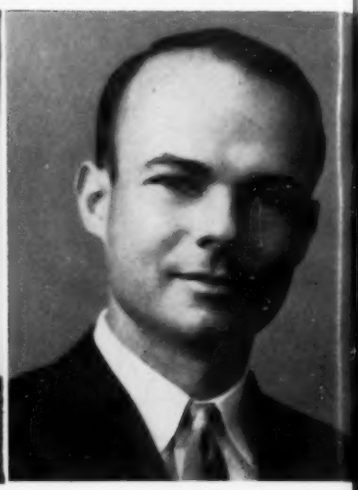

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Abstracts of Papers

To be presented at

AISE ANNUAL CONVENTION

CLEVELAND PUBLIC AUDITORIUM

CLEVELAND, OHIO

SEPTEMBER 30, OCTOBER 1, 2, 3, 1952

"AIR FILTERS APPLIED TO COOLING SYSTEMS OF ELECTRICAL ROTATING EQUIPMENT"

by FRED C. REUTENAUER, Design Engineer, Elliott Co., Ridgway, Pa.

▲ IN cooling systems of electrical rotating equipment, the cooling air is usually either wholly or in part drawn from outdoors. Because of the impurities which are always present in outside air and which are especially high in concentration around industrial plants, it is necessary that the air be cleaned in order to protect the machinery and reduce maintenance. Air filters are extensively used for this purpose.

Three principles of air cleaning are employed in the various air filters available. These principles are dry filtration, viscous impingement, and electrostatic precipitation. The choice of the proper type of air filter for any particular application involves many considerations including the air volume, allowable pressure drop, dust concentration, degree of cleanliness needed, space available, and type of maintenance wanted.

Efficiency, pressure drop, dust-holding capacity, and method of maintenance are the characteristics of greatest importance in a filter. Because of the many methods of determining air filter efficiencies, the published data is often confusing and misleading. Several test procedures have been developed: count, weight, visual comparison, discoloration, etc.; but none gives the complete answer for all types of filters and the results from one test method are not directly comparable with those obtained from another, nor can they be interpolated to arrive at a common factor of comparison.

Disposing of the material collected becomes a maintenance problem which requires labor, work space and other items which have a direct bearing on the cost of installing and operating a filter. Self-cleaning, reconditioning by washing or vacuum cleaning, renewing the filter medium and replacing the entire filter are the four methods of disposal used.

The actual effectiveness of any air filter installation depends not only upon the filter itself, but also upon the associated equipment. Maximum effectiveness can be obtained only by careful consideration of other important factors in the design of an air filter installation in addition to the proper choice of filter.

"TRANSFORMER OILS FOR MODERN INDUSTRY"

by ANDREW S. MORROW, Staff Engineer, Lubricants Department, Shell Oil Co., New York, N. Y.

▲ THE increased power demands prevalent through the United States have thrown a greater burden on all utility equipment. Of particular significance, transformers of all types have had to operate at higher loadings with the result that oil temperatures have been elevated materially. Consequently, transformer oil life can be severely reduced since the oxidation rate of petroleum fractions is approximately doubled for each 10 C rise in temperature. With accelerated oil deterioration, transformer efficiency can be reduced, and overhaul and oil change periods lowered.

In addition to various auxiliary devices to either exclude air or cool the oil, it has been found that oil stability can be improved by incorporating a satisfactory oxidation inhibitor in a carefully selected transformer oil base stock. The manufacture of an inhibited transformer oil requires careful refining and treating techniques to obtain maximum inhibitor susceptibility. The inhibitor selected must not have any adverse affect on the electrical properties of the base oil or on the other components of the transformer, as well as being nontoxic and stable in the presence of ultraviolet light.

An inhibited transformer oil has been commercially available since 1945 and, based on accelerated laboratory evaluations in both oxidation tests and in various types of test transformers, has been found to have an expected service life three to five times greater than conventional transformer oil. In field performance, the inhibited oil has been successfully used in all types of transformers, switch gear and other electrical equipment.

The final analysis of the improved service performance of units filled with an inhibited oil will not be available for many years to come, but from the data

already accumulated, it appears the user will realize definite economic and operational advantages.

"A SIMPLIFIED AUTOMATIC INGOT BUGGY"

by I. N. TULL, Electrical Superintendent, Republic Steel Corp., Cleveland, Ohio, and HUGH S. FEGELY, Control Engineer, Westinghouse Electric Corp., Buffalo, N. Y.

▲ THE ingot buggy described in this paper is cable driven from a drum centrally located in a basement under the buggy track. The buggy receives the ingot from nine fixed locations and delivers the ingot to a receiving table at the end of the track. The ingot cradle engages a cam at the end of the receiving table and in the last few feet of travel, tips the cradle forward and deposits the ingot on the table rolls. The track and receiving table are in line so that the buggy stalls against the end of the table for discharge of the ingot. The 30,000-lb buggy travels at a maximum speed of 1200 fpm.

A single 200-hp motor supplied from a 150-kw variable voltage generator, drives the cable drum. All movements of the buggy are controlled by the operator located near the receiving table. Nine push buttons corresponding to the nine positions give him complete control. The selection established by push buttons may be changed at any time. A conveniently located meter indicates the position of the buggy at all times.

A simple and reliable control scheme provides complete intelligence for governing the speed of the buggy, such as traversing any given distance in the shortest possible time without overshooting, and stopping accurately at the desired position. This control scheme makes use of a rheostat driven by the cable drum. The rheostat is connected in a bridge circuit. Sensitive polarized relays detect the direction and amount of bridge unbalance and cause the generator voltage to build up in the required direction to move the buggy and thus, restore the bridge circuit balance. The buggy will be located at the desired position when the bridge circuit becomes balanced.

"CHROMIUM PLATING AS USED IN THE IRON AND STEEL MILLS"

by JOHN B. ALLEN and JEROME D. TULLOCH, Chromium Corp. of America, Chicago, Ill.

▲ THE use of electroplating, and chromium plating in particular, has grown to such proportions as a maintenance tool and a medium for product quality control, that it is worthy of acute consideration by the engineering fraternity. The maintenance engineer and the production supervisor are constantly on the alert for methods and materials by means of which they can reduce cost of upkeep, increase production and improve quality of product. The use of electroplating as a tool to assist in accomplishing these aims has a relatively short history, for practical purposes about twenty-five to thirty years, and begins with the development of commercial processes for chromium plating.

Any metal which can be electro-deposited is a potential tool for industrial application, but chromium plating undoubtedly leads the field in general adaptability and all around use, with nickel an expanding second place runner. The article mentions some isolated applications for nickel and copper plating, but concentrates on chromium plating, stressing applications of proved and potential value to the iron and steel industry.

For example, the case of the main cylinder of a 10,000-ton forging press, how it was plated, the effect on maintenance and production schedules and the manner in which the cylinder itself was serviced is of interest to all concerned, and so, too, are the chromium plated furnace door control plungers, which have seen continuous service for five years with a minimum of maintenance expense.

Practically every phase of basic metal reduction and refinement, by product processing and general metal working has potential use for chromium plating. Specific applications are discussed together with performance records and important factors affecting the successful use of electroplating.

"MATERIAL MAINTENANCE PROGRAM"

by J. B. WHITLOCK, General Maintenance Engineer, and J. E. ANDERSON, Research Engineer, Armco Steel Corp., Middletown, Ohio.

▲ THE continuous and integrated processes employed today by modern industry demand and must receive delay-free equipment operation. The problem of providing this delay-free operation is one that confronts every maintenance engineer. The solution to the problem must be found.

One phase of the solution to this problem of maintenance is a constructive material application program. Material application failures are always at the base of an equipment failure and expenditures for maintenance materials form at least sixty per cent of the total maintenance cost.

A maintenance material program may follow many various methods of approach and execution, but the one we employ is centered around two main sections—"Failure Research" and "Material Betterment." Failure Research covers the investigation of every equipment failure possible. It seeks to find out why the failure occurred and what can be done to prevent the same or a similar accident from happening again. Failure Research also assigns each failure to one of four groups which we believe cover the field of failure responsibility. Material Betterment, as the term implies, covers the investigation of new and better materials, so that material improvements may be made in existing applications. Both of these phases of the program we employ are essential for its successful operation and both must be pursued vigorously if the desired improvements are to be made. Illustrations in the paper cover both phases of this maintenance material program in order to show the type of work that is being done.

The ten years of experience that we have had with maintenance material investigations have proven conclusively that the work does produce satisfactory results. Many recurring failures have been eliminated and improved operating conditions have been the result. However, the work has also pointed out one startling fact in that in the ten years we have been able to barely scratch the surface in this field of material application. Much remains to be done.

"NEW DEVELOPMENTS IN SUBMERGED MELT WELDING FOR STEEL MILL MAINTENANCE"

by D. E. KNIGHT, Development Engineer, Linde Air Products Co., Newark, N. J.

▲ SUBMERGED melt welding is being used increasingly in steel plants to repair worn parts. This paper describes various applications in this field and shows how the process is being used successfully for more and more of the jobs that previously were considered impossible or unprofitable.

Crane wheels, kiln tires, and various types of rolls and shafts are rebuilt by turning them beneath a welding head that is slowly moved across the work. Another application is the repair of broken roll necks and broken shafts. A new procedure is used to reclaim shafts formerly considered too small to repair. These are rebuilt successfully by applying the deposit as a double or triple helix. By using an extension nozzle with the welding head, welds can be made on the inside surface of pipe, cylinders, or heavier articles. Flat surfaces can be rebuilt as easily as cylindrical surfaces by using a mechanized carriage to move the welding head in straight lines over the work. The side beam carriage is particularly adapted to this type of use. An adjustment screw moves the head across the work to position it for welding.

New flexible welding equipment is especially useful in steel plant maintenance because it is so portable and the welding can be done easily in restricted places where fully automatic equipment cannot be used profitably. New adaptions of submerged melt welding are tandem welding and series arc welding. Tandem welding uses two electrically independent welding heads, one following closely behind the other. The chief advantage of the process is increased welding speed and reduced consumption of welding composition. In series arc welding, the current goes from one welding head through the weld puddle to the other head. Very little base metal is mixed with the added metal since most of the energy is expended between the two electrodes.

Submerged melt welding has made it possible to repair much of the material that was formerly scrapped and to return it to use as good as new or even better. With continuing development in the uses of submerged melt welding, we can reasonably expect better, and more economical steel plant maintenance.

"A NEW HIGH TEMPERATURE ALLOY"

by M. N. ORNITZ, Works Manager, and R. H. ENGLISH, Chief Metallurgist, National Alloy Steel Division of Blaw-Knox Co., Blawnox, Pa.

▲ THE limitations imposed upon many metallurgical processes due to the strength and corrosion resistance of the heretofore available commercial heat resistant alloys has long been apparent. Recognizing this fact, we have developed a heat resistant alloy which has properties which permit practical engineering applications at temperatures up to 2200 F. This permits an increase of 200 F over previous practical design for alloys, and the importance of this from an industrial point of view is shown. The use of this new alloy, which we have designated as NA22H, allows higher load carrying capacity at these elevated temperatures of 2000 F and above. In addition it has greater resistance to oxidation under the normal temperature fluctuations encountered in furnace operations at these temperatures. Because of these properties of strength and oxidation resistance at 2000 F and above, NA22H has enabled those who have used it to increase productivity, to use less alloy and to design equipment which would not otherwise have been possible.

Data is presented in this paper covering the properties of NA22H in stress to rupture, creep and corrosion resistance in hot gases. These data are compared with those of the standard commercial heat resisting alloys 35 Ni–15 Cr (HT), 25 Cr–12 Ni (HH) and 25 Cr–20 Ni (HK) which are now used for temperatures not exceeding 2000 F.

This newly developed material has been thoroughly tested in many types of industrial applications and has proven itself to be of positive economical advantage and is resulting in an increased demand. A review of case histories of some applications is made showing benefits that have been and can be achieved by use of this alloy, as well as discussion of its limitations and future possibilities.

"EXPERIENCES WITH OXYGEN CONTROL IN OPEN HEARTH FLUE GASES"

by F. P. HUBBELL, Superintendent Fuel Department, Homestead Works, United States Steel Co., Munhall, Pa.

▲ THE possible advantages from controlled excess air in open hearth flue gases, as related to furnace production rates, combustion efficiency, and maintenance requirements are briefly outlined. Selection of sampling points and methods of flue gas analysis for excess air determination in furnace flue gases are discussed.

A description is given of an installation for continuous sampling and control of oxygen content in flue gases on a 225-ton basic open hearth furnace. Details of the performance and maintenance requirements of the various units used in the sampling and control system are described. No definite conclusions covering furnace performance while on oxygen control are

reached. Future design changes to eliminate major difficulties experienced with present installation are also discussed.

"APPLICATION OF AUTOMATIC COMBUSTION CONTROLS TO A NEW OPEN HEARTH SHOP"

by F. S. SWANEY, Combustion Engineer, Pittsburgh Works, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

▲ ONE of the most important features of the present expansion program at the Pittsburgh Works of Jones & Laughlin Steel Corp. is the new open hearth shop recently put into operation. The shop consists of eleven stationary furnaces of 250 net ton capacity. The design features include suspended basic ends, single pass checkers, and natural draft stack. The furnaces are fired with residual tar or fuel oil in combination with coke oven gas. Facilities for the use of oxygen in both the bath and burner have been provided. The instrumentation on each furnace includes flow metering of liquid fuel, combustion air, atomizing steam, oxygen, and coke oven gas; temperature measurement of roof, flues, stack, superheated steam, and liquid fuel. Automatic controls provided include fuel flow, fuel-air ratio, roof temperature, atomizing steam pressure, furnace pressure, and liquid fuel temperature. Each furnace is also equipped with a recorder for bath temperature measurement using a platinum thermocouple. Furnace reversal is automatic from either time or temperature difference and is accomplished electro-pneumatically. All recorders and indicators are mounted on a panel board which is housed in a glass front pressurized control room. The operator's controls, including push buttons, transfer switches, timers, manual control stations, etc., are mounted on a console which forms part of the front wall of the control room. All measurements involved in the control system are converted to electrical or pneumatic impulses at the primary element location. Since all controls are pneumatic also, only electric and air transmission lines are carried into the control room. This design was adopted in order to improve housekeeping as well as to eliminate the safety hazard attendant to the running of fuel lines in confined areas. Miscellaneous control instrumentation includes gas flow metering and gas pressure regulation stations, liquid fuel circulating line metering and sectionalized temperature control, and pilot viscosity measurement of fuel oil and tar.

"THE MAGNETIC AMPLIFIER AND ITS APPLICATION IN THE STEEL INDUSTRY"

by W. E. MILLER, Manager, Steel Mill Section, Industrial Engineering Department, General Electric Co., Schenectady, N. Y.

▲ THE application of magnetic amplifiers in the iron and steel industry has been speeded by the tremendous recent progress in the art of regulating system design. The story of the amplistat, a form of self-saturating, static, magnetic amplifier for regulating circuits was presented to the Association of Iron and Steel Engineers just three years ago. The original development installations reported at that time are still in service. In addition, more has been learned of the possibilities and limitations of the magnetic amplifier. Analytical studies have been made of more regulating systems, with and without magnetic amplifiers. Also, new applications have been made and much practical experience has been gained.

A brief review of the principles of the operation and application, as well as a look at the systems now in service in the iron and steel industry and at the future possibilities, is now in order. For example, on pickling lines, the amplistat-magnetic pick-up loop control system has replaced the always corroded dancer roll loop control system. The new system was application-engineered to reduce maintenance and to increase pickling efficiency. On ignitron mercury-arc rectifiers the use of the amplistat has simplified the excitation circuits. Here again, performance has been improved; this time because the amplistat is ideally suited to the characteristics of the ignitron rectifier. These are only two of many applications where the magnetic amplifier has been used to advantage.

The magnetic amplifier has proved itself to be a sturdy and a versatile tool in regulating systems. It is also a simple tool because it is a static device with no moving parts or electronic tubes. However, even the simplest tool must be well understood and its limitations appreciated before it can be used to the maximum benefit. Basically, it must be realized that the magnetic amplifier performs as a current amplifier while the rotating amplifier acts as a voltage amplifier. The rotating amplifier is inherently reversible while the magnetic amplifier has the irreversible characteristics of its component rectifiers. With the understanding of these fundamental differences, and an understanding of regulating system analysis, along with a complete knowledge of the characteristics of the process to be controlled, magnetic amplifiers can and will be used to improve electric system performance with resultant improvement in product quality and increase in product output.

"THE MEANING OF COMMUTATOR FILM"

By LEON D. COOK, Supervisor Substations, Commonwealth Edison Co., Chicago, Ill.

▲ SOME commutator and armature ills may be diagnosed by the observance of commutator films. Illustrations in the paper show a number of commutator markings, the meaning indicated is discussed together with suggestions for correcting the machine or brush maladjustments. Commutator film is formed principally by brush material deposits by the negative brushes of a generator. This process is explained and also how the proper thickness and quality of the film may be maintained by the use of different brush grade combinations and added abrasives.

The matter of brush tension and its relation to friction and film maintenance, the effect of abrasives

added to brush material when used on the higher speed commutators are presented.

A discussion and explanation relative to the transfer of electric current between moving bodies follows, showing how the "hot spots" on the brush contacts are responsible for selective action when brushes are operated in parallel. How selective action may be relieved by slotted brushes and grooved rings is also shown.

The Iowa State College has conducted a series of brush experiments sponsored by the Commonwealth Edison Co. From the result of their research is included some unpublished data dealing with the effect of atmospheric conditions on the operation of brushes. Pictures and information will show in detail the action upon the brush contact surface at the time of disintegration due to low humidity. The discussion is continued on the general effect of atmospheric content on commutator film and the part water (as water vapor) in the air plays on film and brush friction.

In addition methods will be illustrated that have proved satisfactory in controlling the humidity of the air surrounding brushes while in operation. Methods of humidity determination and control are discussed together with practical methods for installation of humidifying equipment.

"SYNCHRONOUS MOTOR TORQUE REQUIREMENTS FOR STEEL MILL APPLICATIONS"

by DR. WILLIAM A. THOMAS, Electrical Engineering Manager, The Electric Products Co., Cleveland, Ohio.

▲ SYNCHRONOUS motors are finding wider application in steel mill drives because of improvement in insulation, coil bracing and mechanical ruggedness. Excitation systems, control and starters have been improved and simplified. Designers are now able to furnish synchronous motor torques for difficult application.

The AIEE and NEMA specify torques for general purpose motors and for a standard list of applications. These torques are given for starting, pull-in and pull-out which apply to specifically defined conditions. In general, applications may have quite different requirements than these standards. It is important for users to know what starting, pull-in and pull-out torques mean and what their load requires.

Pull-out torque is a function of motor strength and air gap length. It is the maximum available torque under synchronous operation with normal excitation and can be designed into a machine independent of the starting and pull-in torques. Starting and pull-in torques are those available during sub-synchronous operation with pull-in defined for 95 per cent speed. The values which can be obtained are varied by the design of the rotor amortisseur winding just as with a squirrel induction motor.

High starting torque with moderate pull-in is obtained by using brass rotor bars. High pull-in torque with moderate starting is obtained with copper rotor bars. In some applications both high starting and high pull-in torques are required which are obtained by using a double cage rotor winding. Often such a design can provide the required torques with a minimum of in-rush current. There are some applications requiring very low torques and long accelerating periods for which only a partial cage is used. An often misunderstood factor is the field discharge resistance which has an effect on pull-in torque and its proper selection is an important function of the motor designer.

An arbitrary division between high and low speed synchronous motors at 500 rpm has been established. In the low speed class engineers have recognized the superiority of synchronous motors while in the higher speed class the choice has not been clearcut. Application engineers should consider carefully the economies before rejecting synchronous motors as the right choice. Motor designers can design for any torques the user requires. Choice of the synchronous motor gives the advantage of higher efficiency and power factor.

"WIDE RANGE METERING OF OXYGEN IN STEEL PLANTS"

by M. S. GARE, Manager, Ring Balance Division, Hagan Corp., Pittsburgh, Pa.

▲ AMONG the various reasons for increased interest in wide range metering of oxygen in steel plants is the peculiar flow pattern produced by the use of an automatic scarfing machine. With oxygen cost substantial and the scarfing machine flow rate very high for only a few seconds time, the metering system must be an outstanding device to function as a cash register.

Ring balance mechanical meters are measuring this fantastic type of load in many plants. Systems utilizing single or multiple instruments depending on the application are recording and integrating these flows reliably over ranges up to turndowns of 800 to 1. Readings are automatically corrected for pressure and temperature variations.

In a multiple system, when the flow exceeds the capacity of one meter to measure, the next higher meter is automatically switched into service and so continues on up to the capacity of the system. Various combinations of instruments and manifold piping have been designed so as best to comply with local plant needs. One of the requirements of such a system is its ability to measure accurately over a wide range in spite of the fact that at the end of the day, the total integrated consumption may be only 5 to 10 per cent of the maximum capacity of the metering system.

Variations of problems encountered in building these systems are interesting. For example, in one multiple system, the lowest range meter was below the plant base load most of the time, and consequently, it did not register frequently. However, during the 1952 steel strike when all plant oxygen consuming activities were shut down, this same low meter quickly pointed up line losses due to leaks. Saving of oxygen thus lost would quickly pay for the meters involved.

Another interesting disclosure was obtained from "slow motion" charts made at 5000 times the speed of rotation of a standard 24-hour chart. These charts illustrate in exact detail the flow pattern of oxygen used

in a scarfing machine. It would have been impossible to analyze this pattern on a standard 24-hour record.

Speed of response, stability, and ease of checking calibrations are musts in a reliable wide range oxygen metering system.

"CONTINUOUS PROCESS PRODUCES HIGH STRENGTH OIL WELL CASING BY QUENCHING AND TEMPERING CARBON STEEL"

by F. H. BREMMER, Chief Combustion Engineer, and F. J. ZEHNDER, Project Engineer, Spang-Chalfant, Division of The National Supply Co., Ambridge, Pa.

▲ SINCE 1947 a continuous quench and tempering line has been successfully producing high strength oil well casing from plain carbon steel at the Ambridge, Pa., plant of the National Supply Co. During these 5 years, over 80,000 tons, or more than 7 million feet of quenched and tempered casing, have been produced on this equipment.

A high strength casing, A.P.I Grade N-80, used in deep oil wells, usually is made of a normalized and tempered steel with alloy additions. With the recent restrictions on the use of molybdenum and an overall effort to conserve all alloying elements, the development of a process which reduces the amount of alloying elements, was indeed timely. Since 1947, we have produced over 7 million feet of quenched and tempered casing on this equipment. In the production of this casing, we have saved over 300,000 pounds of molybdenum and nearly 1,500,000 pounds of manganese.

A secondary objective for the use of continuous heat treating equipment was for the production of casing having a minimum yield strength of 110,000 psi, for use in oil wells to depths of 20,000 feet or more.

Considerable experimental work has been conducted to produce this grade of casing, both in the upset and non-upset types. These experiments have been highly successful and the material produced has satisfactorily met all of the physical properties required for this higher strength casing.

The continuous heat treating line contains a series of high intensity radiant gas-fired furnaces and quench heads. Casing having a maximum diameter of 9⅝ in. and a maximum length of 50 ft can be processed through this equipment.

"CASTABLE REFRACTORIES IN THE STEEL MILL"

by J. D. McCULLOUGH, Chief Engineer, Refractories Division, The Babcock & Wilcox Co., New York, N. Y.

▲ THE use of castable refractories in the steel industry has shown a marked increase in recent years. The acceptance can be traced to improvement in properties, to shortage of skilled masons, to elimination of special shapes, and similar allied reasons.

The author points out the distinguishing features between refractory castables, plastics, and ramming mixes. A brief discussion is given concerning various grades and types of refractory castables and the properties which are of importance to the user.

Methods of installation are covered, as well as the significance of proper curing and drying. Various installations are discussed such as burner blocks, cartops, barrel type high speed tube normalizing furnaces, soaking pit covers, soaking pit walls, and slab heating furnace walls. The author closes with reference to further possibilities of future applications.

"INJECTION OF NATURAL GAS AND OXYGEN INTO THE BLAST FURNACE"

by DR. JULIEN O. RAICK, Ingenieur Civil des Mines A. I. Lg. Brussels, Belgium, and JAMES E. BRASSERT, Vice President, H. A. Brassert & Co., Inc., New York, N. Y.

▲ THE paper presents the results of a new method of calculating data on blast furnace performance which is especially suited for evaluating differences in operation resulting from either a change in the materials charged or, more especially, from a change in composition of the combustion medium (i.e. steam or oxygen injection, etc.). Further prediction can be made regarding the effect of gas injections into the critical zone of fusion of the slag.

In each case in which forecasts are made concerning the effect of varying the combustion medium or of gas injection, a complete analysis is first made on the basis of normal operation with the particular raw materials used. Then, a further analysis is made for the case of the modified operation, using the same raw materials. Finally, direct comparison is made of coke and flux consumptions, blast temperatures, production rates, volumes of gas used, and top gas analyses and volumes, permitting direct comparison of expected costs with normal costs. In this manner, such questions as to whether to inject steam or whether to dry the blast can be answered with great assurance on the basis of actual operating conditions, local average humidity and local burdens, thus avoiding expensive tests in cases where they can be shown to be unjustifiable.

The greatest untried experiment in the blast furnace is shown to be the injection of reformed natural gas into the critical zone combined with oxygen enrichment of the blast and pressurized operation. Calculations permit evaluating the relative costs of operation in regions where natural gas and coke costs differ materially. These calculations and predicted operating data are never the equivalent of full-scale tests but they serve the purpose of pointing the direction for development programs and of providing the best assurance for a return on new investments.

"EXPLORATION AND DEVELOPMENT OF A NEW IRON MINE"

by R. P. BREMNER, Assistant to Vice President Charge of Operations, Youngstown Sheet & Tube Co., Youngstown, Ohio.

▲ THE new foreign iron ore developments in Labrador, Liberia, and Venezuela and concentrates from

the low grade taconites of Minnesota will soon be available in volume. These new sources of iron will replace a major portion of the high quality open pit ores of the Mesabi as they are slowly being depleted and will provide much of the additional tonnage required by the iron and steel industry's expansion program now under way.

Ores from these new foreign sources will have to be competitive with natural Lake Superior ores at the iron and steel plants located on and near the Great Lakes as long as such natural lake ores are available in large quantities. Expensive railroad and dock facilities, ocean freight rates, and/or other high investment charges may place high transportation and overhead burdens on these ores. Therefore, in order to make them competitive at Great Lakes ports, they will have to be mined and prepared at the lowest possible cost.

There are two basic mining methods: open pit, and underground. If an ore body is near surface, flatly dipping, and of large lateral extent, the ore may be mined on a mass scale—as an open pit—with large and powerful drilling, loading, and haulage equipment which permit marked labor economies. When exploration shows an ore body to be deeply buried, narrow, and steeply dipping or covered by a heavy rock overburden, it may require one of the underground mining methods.

In general the cost of mining an ore body by open pit methods is less than any of the underground methods. During the past few years increases in labor and material costs have enlarged the relative advantages in favor of open-pit mining.

The experienced mining and geological organizations of the major companies which are exploring and developing the foreign iron ore fields are, for the present, concerned only with rich ore bodies that can be mined by open pit methods.

"MATERIAL HANDLING LAYOUT OF BLAST FURNACE AND COKE PLANT AT FAIRLESS WORKS"

by CARLETON LORD, Materials Handling Engineer, United States Steel Co., Pittsburgh, Pa.

▲ STUDIES in recent years have revealed that a large per cent of all the direct labor manhours involved in making steel are related, either directly or indirectly, to some form of materials handling. It was natural, therefore, that plans for the new Fairless works of the United States Steel Company should attach prime importance to the provision of proper handling facilities.

This paper discusses the methods and equipment which have been planned to handle raw materials at the coke plant and the blast furnaces. These facilities include a boat slip, two boat unloaders, a car dumper, ore storage yard and trough, one ore bridge, two transfer cars on the blast furnace trestle, coal storage yard, coal mixing bins, coke screening station, and a system of interconnecting conveyors.

The design of the handling system required close attention to present as well as future requirements for material movement. For example, although the Fairless works will commence operations as a completely integrated steel mill with two by-product coke batteries and two blast furnaces, the basic layout has been planned to permit orderly expansion of production facilities. Thus, handling facilities had to be designed to provide increased capacity by conversion or addition as required.

Also, it was necessary to provide for future changes in sources of raw materials which will alter the manner of delivery. For instance, the bulk of the initial ore receipts will come by rail from the Mesabi Range; ultimately domestic ores will largely be replaced by Venezuelan ores, which probably will be shipped directly to the mill by water.

Thus, the raw materials handling system has been designed to provide complete flexibility consistent with sound economic engineering and to preclude future costly change-overs.

"LUBRICANTS FOR DRAWING METALS"

By ALLEN A. BROWN, Reilly-Whiteman-Walton Co., Conshohocken, Pa.

▲ FOLLOWING a review of fundamental considerations, in the severe cold working of metals, the prevention of welding of portions of work piece surface to forming tools is discussed as a most important function of a drawing lubricant. This ability to prevent welding must be obtained from a lubricant which will also provide a low frictional coefficient, although maximum reduction of surface friction is not always desirable.

These primary drawing lubricant functions are redefined in terms of separation and slip. The separating and slip producing phases may be applied separately or simultaneously, according to the requirements of the particular operation.

Fluid film lubrication conditions do not prevail in drawing operations, and non-polar, non-reactive lubricants, such as mineral oil, are held to have little or no value. Boundary lubrication conditions are encountered, and boundary lubricants are classified: coatings, solid lubricants, reactive lubricants, and polar lubricants. The inability to make distinct categories is pointed out. The combination of various types of boundary lubricants into a single compound is common practice.

Other than separating and slip producing ability, practical drawing lubricants must meet many secondary requirements. The necessity for ease of application, absence of stain and corrosion, removability and similar characteristics of such lubricants are illustrated by actual experiences.

The important role played by the fats and their derivatives, as drawing lubricants or components thereof, is treated at length. An explanation of the polar activity of these materials is presented. Charts show characteristics of natural fats and waxes, and products resulting from saponification, sulphonation, and polymerization of fat derivatives. The wide utility of such products is explained by their ability to meet both primary and secondary requirements previously outlined.

While drawing lubricants are emphasized, other cold forming operations, such as cold rolling, are closely related, and most of the information, with respect to fatty type lubricants, can be applied generally. Recent developments in fatty lubricants for cold working are enumerated.

"THE FUNCTIONING OF A LUBRICATION ORGANIZATION IN HEAVY ROLLING MILLS"

by ROBERT R. TAYLOR, Division Engineer, Maintenance and Lubrication, United States Steel Co., Gary, Ind.

▲ THE purpose of the paper is twofold: first, to stress the importance of good lubrication organizations in the steel industry; and second, to emphasize the important fact that this organization must function properly to be of value.

The author has chosen a typical heavy rolling mill division of a steel plant to use as an example. The history of this typical plant in regards to lubrication practices before the organization was developed is discussed and the entire development of the lubrication organization is taken up step by step as the lubrication organization was developed.

After the lubrication organization of this typical division has been developed, the author indicates the functions which each person in the organization must perform in order to insure the success of this organization.

This paper is primarily on organization and is presented with the idea that better lubrication organizations in steel plants will produce better lubrication practices and methods.

The author emphasizes to management of the steel industry that good lubrication methods and practices result in better maintenance, lower power costs, and increased production at lower cost. The author also points out the fact that lubrication methods and practices can be costly items unless the lubrication organization functions properly—with a properly functioning lubrication organization being a necessity in present day steel plant operation.

"REPLACEMENTS FOR PALM OIL IN COLD ROLLING STEEL"

by ROBERT C. WILLIAMS, Director of Research, The Ironsides Co., Columbus, Ohio.

▲ WORLD War II intensified the efforts to find a workable domestic replacement for imported palm oil which has been widely used for rolling tin plate since the start of the industry. Not only enemy action, in the recent world conflict, but the ensuing and still current unstable international situation stimulated research to develop a satisfactory replacement.

Many tin plate operators will recall the rigid controls over the use of palm oil during the recent war years, and others will recall that it was taken off the market for all but essential uses.

Reports from the U. S. Department of Commerce show that some 30,000,000 lb of palm oil are used annually by the tin plate industry and for other metalworking applications. A large percentage of this quantity is used by tin plate operations alone. This includes not only the palm oil used in rolling but also on the tin pots. With the progress of electrolytic tinning a decreasing proportion of palm oil has been used on tin pots.

Requirements for the replacement — The replacement for palm oil should meet the following requirements:

1. It should be of domestic origin so as to avoid overseas shipment and foreign controlled sources.
2. It should be available in ample quantity.
3. It should be reproducible in regard to specifications and be subject to chemical control.
4. It should *do the job* of palm oil as well or better.

For many years palm oil has been successfully replaced for many cold rolling applications.

Recent developments—More recently sperm oil has been successfully used to some extent as a tin plate rolling lubricant as well as for other cold rolling jobs. As a highly desirable replacement for palm oil it falls short in that it is not of domestic origin and its production is subject to enemy action in time of war.

While palm oil is not necessarily the ultimate in rolling lubricants, the successful replacement might well be designed to duplicate, essentially, its chemical and physical properties. A study of the composition and properties of palm oil indicated that it should be possible to produce a material which would closely duplicate palm oil through the use of available, domestic raw materials. The replacement for palm oil designed with this in mind is designated as No. 1B.

The first cold rolling tests were carried out on 18-8 stainless steel. Performance was satisfactory. After repeated production experience, which proved that the chemical control of the processing of No. 1B was reproducible, a trial run on rolling tin plate was proposed with reasonable confidence.

After the chemical laboratory at the steel mill had satisfied themselves that the No. 1B substantially duplicated palm oil a two hour run was made.

The No. 1B was applied to the strip at the pickle line as well as on the tandem mill. The handling throughout was the same as with palm oil. No changes in procedure were required. The results were comparable throughout. The reductions, mill loads, finish, washing, annealing, temper rolling and tinning, both electrolytic and hot dip, were comparable and satisfactory in all respects.

Controlled free fatty acid content—The free fatty acid content of the No. 1B can be controlled to plus or minus 0.5 per cent at the request of the mill operator. It will be readily appreciated that experimenting with lots of lubricant having extremes in free fatty acid content could be an expensive gamble when dealing with production mills. No performance data is therefore available regarding lots having free fatty acid contents of less than 8 or more than 14 per cent.

Further tests and use—As a result of the early successful mill tests No. 1B has been now tested or is in use in a majority of the tin plate mills in this country and Canada. Regular production of No. 1B has reached

a substantial figure. Tests have been made involving all forms of application: direct, solution and proportioning pump mixing with water. Results have been uniformly good and in some cases superior to palm oil. It is believed that uniformity of the No. 1B, made with customer specified free fatty acid content, eliminates variables in performance which are occasionally encountered with palm oil. Experience in some mills has shown lower consumption as compared with palm oil, gauge is reached sooner on starting up and shape is held better. Tonnage increases have not been uncommon.

It is probable that further improvements will be made, since it is hardly possible that natural palm oil could have all the virtues of the ultimate in rolling lubrication. The engineering advances in cold rolling always keep the ultimate ahead.

"PROCESSING PROPERTIES AND APPLICATIONS FOR COLD FINISHED STEEL BARS"

by J. F. BYERS, Metallurgist Bar Products, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

▲ THIS paper deals with the overall picture as related to the cold finishing of carbon steel bar products. Considerable space is devoted to a description of the cold finishing process and the equipment and practices employed to achieve the desired results in the finished products.

Discussion of the properties of cold finished bars demonstrates the high order of quality obtainable in respect to size, section, straightness, surface, mechanical properties and machinability. Also the importance of control of these physical characteristics, essential in the product for the end use, is also covered in the paper.

"THE EXTRUSION OF STEEL, EQUIPMENT, OPERATION, AND PRODUCTION"

by JACQUES SEJOURNET, General Manager, Comptoir Industriel D'Etirage Et Profilage De Metaux, Paris, France.

I — EQUIPMENT

▲ A. *Presses formerly used for putting the process into operation*—The first press used for studying the extrusion of steel and bringing it to the point of production was of 600 metric tons capacity, installed in Paris at a shop of Comptoir Industriel D'Etirage Et Profilage De Metaux. This press had to undergo important modifications in order to permit obtaining commercial results.

A new press of 1500 metric tons was subsequently ordered and installed at Persan, France. Its operation permitted determining with sufficient precision the necessary characteristics of extrusion presses which were later ordered by the various companies acquiring licenses for the use of the process.

B. *Presses in use*—

a. Presses for nonferrous metals modified for steel extrusion.

These presses technically should permit of adaptation to the extrusion of steels, but their operating frequency remains quite low. They are applicable to the conversion of metals of high value.

b. Presses especially designed for the extrusion of steel.

The principal new characteristics of such presses are described.

c. New concepts on special press designs for the extrusion of steel.

The author describes the modifications envisaged for increasing the operating frequency.

C. *Description of presses that will be used in the future*—When the range of production of a given press is greatly extended, it is necessary to have a specialized press in order to obtain low operating costs.

a. High alloy steels and rare metals.

With the tonnages to be converted being quite small, it will be necessary to employ presses with variable pressure, thus permitting the performance of all operations on a single unit, the operating cost being secondary.

b. Low alloy steels.

One would operate presses at their normal pressure for a sufficiently large production range, the tonnages in each category being still small.

c. Common steels.

Presses should be highly specialized in order to obtain minimum production costs.

d. Mechanical presses.

The paper describes the advantages and disadvantages of these presses and their possible application in the extrusion of steel.

II — OPERATION

The author describes the following operations:

A. Preparation of billets.
B. Preheating.
C. Final heating.
D. Piercing.
E. Untwisting and straightening.
F. Pickling.

III — PRODUCTION

A. *Strokes per hour and tonnage*—The author describes the operating frequencies already obtained and those regarded as possible of attainment in the future. Minimum and maximum tonnages are tabulated, as future possibilities with various types of presses under various operating conditions.

B. *Production costs* — Several indications of costs are given in the form of comparisons between rolling and extrusion.

"A MACHINE TO COLD REDUCE 18-IN. TUBING"

by GRAHAM B. BROWN, Administrative Assistant, Tube Reducing Corp., Wallington, N. J.

▲ DURING World War II, tube reducing machines were used to make tapered steel cores for airplane propeller blades. Subsequent development of military items has increased the demand for large diameter light wall cold finished seamless tubing. The Department of Navy requested the design of a tube reducing machine of sufficient size to meet the estimated needs for the future. As a result of a preliminary study, it was decided to make two machines, one to reduce 10 in. diam tubing and the other to reduce 18 in. diam tubing. The large machine consists primarily of a roll housing, weighing close to 150 tons, which travels back and forth horizontally for about 7 ft. This housing carries 50-in. diam rolls with removable insert dies provided so that a complete roll change is not required for each change of pass. The insert dies weigh about 4 tons and are made of through hardening steel, heat treated to a surface hardness of Rockwell C-60. The roll neck bearings are the double roller spherical type in a size having the largest load rating ever manufactured. The saddle and rolls are driven by a hydraulic system through a pair of 13-in. diam cylinders requiring 5400 gpm of oil at a pressure of 2500 psi. The drive system is equipped with a servo-mechanism control and safety devices to protect it in the event of a jam. The two pumps are a special design wobble plate type, driven through speed reducers by 700-hp synchronous motors. The tube is fed intermittently into the rolls in small increments and is turned about 60 degrees between each pass of the saddle, by means of large hydraulic motors. The total weight of the machine is about 650 tons.

"OIL-MIST LUBRICATION FOR INDUSTRIAL MACHINERY"

by E. RALPH HARRIS, Alemite Division, Stewart-Warner Corp., Chicago, Ill.

▲ DURING the past several years, an evolution has been taking place in the lubrication methods and practices of American industry. Management is becoming conscious of the important benefits proved through better lubrication procedure. Machine tool manufacturers and designers are striving for greater productivity, recognizing the need for better bearing design and strict adherence to lubrication schedules.

Outstanding in the field of technological development is the broad acceptance of oil-mist lubrication. Oil-mist lubrication is provided by supplying a controlled low pressure air stream in which microscopic particles of oil are airborne. Oil-mist is produced by a lubricator which has no moving parts and only two simple adjustments. One regulates the flow of oil while the other adjustment controls the air pressure. Pressure within the system is maintained through the use of fittings of controlled orifice which deliver prescribed amounts of oil to the point of end use. Delivery of oil in the form of mist is accomplished through a "mist" fitting; solid oil, through conversion of mist to oil in a condensing fitting; or by spray method to exposed areas such as cams, gears, or chains, by means of a spray fitting.

Its function is continuous and automatic, overcoming one of the greatest problems in industry, the possibility of human error. The paper includes photographs of actual installations depicting several interesting applications presently employed in the steel industry.

"THE EFFECT OF THE LUBRICANT ON GEAR PERFORMANCE"

by V. N. BORSOFF, Research Engineer, and S. S. SOREM, Research Engineer, Shell Development Co., Emeryville, Calif.

▲ UNDER the continuing trend toward higher speeds and loads in gearing, the main classes of gear failures to be anticipated are tooth breakage, pitting, scoring and abrasion. The mechanisms of these failures are discussed. Progress along avenues of improvement open to the gear designer and the lubricant manufacturer is reviewed. There appears to be a limit beyond which only further improvements in lubrication will permit progress. This requires a thorough understanding of the mechanism of gear lubrication. One school of thought believes that gears can operate only in the boundary zone of lubrication in which part of the load is carried by thin chemically formed and adsorbed film. The other school believes that thick film lubrication is possible and desirable. Earlier tests of this laboratory indicated that with straight mineral oils thick film lubrication exists up to the load and speed at which scoring occurred. Scoring loads were established by observing the contacting teeth surfaces. Since it seemed possible that the previous visual observations failed to detect the thin film conditions, a new technique, involving radioactive tracers, was developed to determine the zone of lubrication in which a gear has operated. The results confirmed the existence of a thick film fully separating the gears up to the conditions at which scoring takes place with straight mineral oils. With additive oils, lubrication is still by the thick film mechanism up to the limits for the base oil. Beyond these limits operation may be continued without scoring but chemical wear is encountered.

"CONSIDERATIONS IN THE DESIGN OF PLAIN BEARINGS"

by A. E. CICHELLI, Lubrication Engineer, Bethlehem Steel Co., Bethlehem, Pa.

▲ THERE are two fundamental approaches to the design of plain bearings, one through the use of the Sommerfeld Variable and the other through the use of the $\frac{ZN}{P}$ ratio. This paper reviews these theories and covers how the Sommerfeld Variable can be used to solve steel mill bearing problems. The paper refers to recent litera-

ture on the subject and shows how a complicated problem can be made much simpler by using the recent data which has become available. The paper also discusses the merits of $\frac{ZN}{P}$ vs. Sommerfeld Variable in every day terms, and also shows by example how the engineering approach to typical steel plant bearing problems can and often does improve and lengthen bearing life. Both of these approaches are briefly described in the Association of Iron and Steel Engineers Plain Bearing Recommended Practice, AISE Recommended Practice No. 1 (tentative), which comes up for reaffirmation in the near future. Some of the later information on plain bearing design could possibly be included in the final version of the AISE Plain Bearing Recommended Practice.

"APPLICATIONS OF THE RADIATION GAUGING METHOD IN THE STEEL INDUSTRY"

by GEORGE B. FOSTER, Technical Director, Industrial Nucleonics Corp., Columbus, Ohio.

▲ EVER increasing demands on the steel industry for closer tolerances in finished strip and plates has pushed presently available gauging instruments to the limits of their accuracy. Increased cold mill speeds have made the contact gauge inadequate.

The high first cost and continuing maintenance costs of X-ray equipment has restricted use of this type of non-contacting measurement.

The availability of radioactive isotopes has led to the development of non-contacting gauges for the steel industry having the characteristics of improved accuracy, extreme ruggedness, reasonable costs, and low maintenance. Installation experience has shown that accuracies of the order of 1 per cent are easily maintained.

The present economics of steel marketing have limited installations generally to precision rolling operations in which the improved accuracy of these new gauging techniques are required. It is to be expected that its advantages will lead to the wider adoption of radioisotope gauging throughout the industry.

"THE RECOVERY OF TIN FROM SCRAP TINPLATE"

by A. J. KROMBHOLZ, Assistant Head, Chemical Development and Research Division, Weirton Steel Co., Weirton, West Va.

▲ ALLOTMENT restrictions on the use of tin, combined with its high price and the unprecedented demand for scrap steel were deciding circumstances which led Weirton Steel Co. to consider establishing a detinning and tin recovery operation for the scrap produced in its tin mills. The need for such an operation was further enhanced by the fact that a high percentage of this scrap is in the form of wound edge trimmings produced in the shearing of electrolytic tinplate. As such, the wound material had no market value as tinned scrap, and its high tin content, ranging from about 10 to 20 lb of tin per ton, made it unsuitable for direct use as steel scrap.

To meet the demand for conserving tin and scrap, a simple alkaline detinning and tin recovery process was developed. The original work on this process was carried out in a small pilot plant with a capacity for treating about 400 lb of scrap per charge. This plant provided the basic engineering design and operating cost data which showed that a tin recovery operation could be made economically practicable.

In outline, the process consists in removing the tin from the scrap with a hot solution of caustic soda and sodium nitrate to form sodium stannate. The latter compound is converted to stannic hydroxide by neutralization with sulfuric acid. After recovery by filtration, the stannic hydroxide is dried to hydrated stannic oxide which is then mixed with coal and reduced to metallic tin in an electric furnace.

The plant, designed and built by Weirton Steel Co., has a capacity for treating about 3000 tons of scrap per month when operated on a three-turn per day basis. The amount of tin recovered depends upon the free tin content of the scrap and the efficiency of operation. Under present conditions, a high percentage of the scrap comes from the production of 0.25-lb electrolytic tin plate. The overall recovery from mixed scrap of this type is about 12.5 lb of high grade tin per ton of scrap processed.

A detailed account of the chemical and mechanical operations and of the units designed for the detinning process is presented by the author.

"DYNAMIC PAINTING IN STEEL PLANTS"

by JOSEPH K. SEYLER, Superintendent, Hazelwood Cold Finishing Department, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

▲ COLOR dynamics is nothing more or less than the scientific utilization of the energy in color to promote efficiency and safety in industry.

After intensive experimentation on machinery and plants with tests incorporating discoveries in the color and color-light fields, color engineers have formulated their findings on the principles of color dynamics. With their research spurred by necessity, they have finally harnessed the inherent power and productivity of color for practical industrial use. From the first, color helped increase the quantity and quality of production, reduced accidents, cut absenteeism, and raised morale through scientific use of its natural psychologic, symbolic, and visual powers. Color does its work in the industrial plant by "moving" critical parts of machinery into focus, "moving" ceilings upward and walls outward, and bringing assembly lines and materials into sharper contrast without actual motion.

In essence, the scientific use of color is based upon principles somewhat similar to camouflage, but in application is diametrically opposite. To camouflage an object, color is used to mislead, to hide, or to obscure; in color dynamics, color is used to highlight, to reveal, to emphasize, and to utilize.

The objectives of color dynamics are: (1) to promote continuity of employment, (2) to improve efficiency of operation, (3) to maintain quality of production.

Since color dynamics is concerned not only with the factory background of walls, floor and ceiling, but also with the machines, eye-strain and the resulting fatigue are minimized, the workers themselves remain more alert and are better able to avoid hazards.

From the viewpoint of the employee, the purpose of color dynamics is to make his working day easier—to keep him happier on his job—and to contribute to his safety—to guard his health by eliminating insidious "eye fatigue," which frequently is the cause of nervous tension.

Every production manager wants his workers to stay on the job—to process the maximum quantity of material—and to have the quality of that work measure up to the highest standards. Color dynamics can make a real contribution toward the attaining of these three objectives. Color dynamics means more and better work per man-hour—and more man-hours per man.

"MECHANIZED HOT SCARFING"

by J. H. ZIMMERMAN, Manager, Development and Process Service, Linde Air Products Co., New York, N. Y.

▲ SUBSEQUENT to the installation of the first hot-scarfing machine in 1935, mechanized hot scarfing has found increasing acceptance in the mills of the United States, Canada, and Great Britain. About fifty hot-scarfing machines now in regular production are operated as an integral part of the rolling mill line, usually at some convenient location between the blooming or slabbing mill and the shear.

Approximately 10 per cent of the current U. S. ingot tonnage is surface conditioned by desurfacer hot-scarfing machines. In addition, two machines, now being installed, will go into production shortly, and five more machines are in construction for installation in 1952-1953. The demand for these machines arises primarily from reduction or even complete elimination of manual secondary conditioning. Increasing costs for manual conditioning, inspecting, handling and reheating, serve to emphasize the advantages of direct rolling practices, as employed by some mills for many years. In such practice the semi-finished product is hot-scarfed, sheared, hot charged for reheating, and finished rolled with no diversion from the production line.

A wide variety of machine designs have been made available to meet practically every mill requirement. Three sizes of billet or bloom scarfers cover ranges of 2 x 2 to 6 x 6 in., 4 x 4 to 10 x 10 in., and 5 x 5 to 14 x 14 in. Slab scarfing machines have also been made available to scarf: (1) slab edges; (2) single slab surfaces, either top or bottom, which require slab turn-over and a second pass through the machine; (3) top and bottom slab surfaces simultaneously; and (4) four sides of slabs simultaneously. A special machine has also been proposed to scarf four sides of either slabs or blooms.

Many new features have been incorporated in scarfing machines over the past fifteen years. These include provision for full-floating action to handle camber, rapid and remotely controlled size changing, automatic positioning and retraction of scarfing units. Many nozzle improvements have also been introduced, the latest being the wide-slotted nozzle which scarfs with a continuous sheet of oxygen to leave an essentially flat, evenly scarfed surface.

Numerous additional machine developments are in the making. Experimental round bar scarfing, soon to become a reality, should prove to be of value in the conditioning of seamless rounds. Flying starts by means of special powder starting developments should make possible continuous passage of the steel through the scarfer without need for the few seconds delay presently necessary for preheating before starting the scarfing cut. Other electronic controls are also under study toward the development of a fully automatic scarfing cycle.

Heretofore, hot machine-scarfing has been restricted to the plain carbon and ferritic alloy steel grades. Recent tests, however, now indicate the feasibility of adapting the powder scarfing process, currently very effective in the cold scarfing of stainless grades, to the hot-scarfing machine, and to thus make possible the primary conditioning of hot stainless steel in the rolling line.

"ALUMINUM FOIL AND ITS USES"

by W. B. HACKETT, Assistant to President in Charge Engineering, Lewis Foundry and Machine Division, Blaw-Knox Co., Groveton, Pa.

▲ THE subject of this paper is tentatively "The Production of Aluminum Foil and Its Commercial Uses," and the substance of this paper is principally a discussion of the manufacture, and rolling mills for the production, of very thin sheets of aluminum commonly known as foil. They can be classified very briefly.

First, is the production of modern high speed 4-high mills for the manufacture of very thin aluminum strip down to 0.0002 to 0.0003 in. thick. Foil was first principally produced on small 2-high mills built mostly, I believe, by a German manufacturer and known as the Schmidt mill. The development of the foil mill as it now is has been of much more recent origin than the rolling mill equipment for the production of steel. However, the improvements which have been developed along with the rolling of strip steel were ideally fitted for the manufacture of high speed rolling equipment for the production of aluminum, copper and brass and allied products of a flat nature. The points of these mills which have been of greatest benefit in bringing this class of equipment to the front are first, the 4-high mill and anti-friction bearing, the oil sleeve bearing, then the roller bearing mill which, however, is still a very important factor in the product realized on this type of equipment. With regard to the bearing side of the mill, the two bearings which have been the most useful have been the roller bearing and the oil sleeve bearing, a very excellent design.

Secondly, was the development of thermal control. This feature has come into prominence and recogni-

tion in the last few years. I believe that this, second to anti-friction bearings, is the most important feature of this class of equipment.

The accessories which are peculiarly adapted to this type of mill are constantly being improved and developed as time goes on. Basically, these mills have not been developed as tandem mills in the thinner stages of the production, due principally to the threading and wrapping of the very thin material. Along these lines we feel certain that considerable improvements are coming.

"HIGH SPEED MILLS AND THEIR APPLICATION TO FERROUS AND NON-FERROUS ROLLING"

by GEORGE PERRAULT, JR., E. W. Bliss Co., Salem, Ohio.

▲ IT was not until a combination of developments, such as metallurgical advancements, improvements in mechanical and electrical designs, crying needs for expedients of economy, and decision to take carefully calculated risks, that many refinements, including increased speeds, were incorporated into new mills.

This emphasis was not solely satisfied by actual direct mill speed-ups, but also by exacting simple, mechanized, efficient methods of handling materials, flowing to and from the mills. Result is today that we have many mills which have been speeded up, either by improved material handling methods, or by actual speeding up of the mill and its auxiliaries, or both.

Among the mills now in actual operation, the fastest is a two-stand tandem tin temper mill for operation at a top speed of 7200 fpm. Another is a five-stand tandem mill operating at a top speed of 5200 fpm., for cold reduction work. Furthermore, it is not difficult to locate quite a few mills operating at 3700 fpm or more. Still more interesting is the recently publicized report of a new five-stand tandem mill about to go into operation, which is designed for 7850 fpm, or 90 mph.

The most repeated question among engineers is: "Are such speeds practical and justified?" This can objectively be answered most reliably by examining the production and operating costs records; and, among high speed mills so far set into operation, the "young" records would indicate that high speeds are indeed justified, *provided*, other factors are considered.

It goes without saying that high speed mills, doing more work in a given unit of time, require more harnessed power, therefore greater electrical equipment investment. Such an investment and the extra required mechanical investment for machining refinements, top quality bearings, dynamic balancing of rotating parts, etc., is sound provided other conditions are altered to keep pace, so to speak, and afford maximum advantages.

First of all, where coils are involved, these must be enlarged by building them up through splicing ordinary sized coils, to realize more full use of the mill, once fully accelerated in rolling. In other words, the ratio of coil handling time to contact (or rolling) time, must be reduced.

High speed mills are not limited to ferrous rolling. The non-ferrous producers likewise have come to recognize the importance of speed; to be fair about it, they recognized the merit of higher mill speeds long ago, but it was only after the chief problem of heat removal from the strip had been licked, that they could make the jump into the speedier mill classification.

Today, however, we find several aluminum mills operating at 3000 fpm, and brass mills operating at 1500 fpm, where the heat removal condition is most critical. This progress was made possible by recent metallurgical discoveries and practices, but most of all by improved coolant system designs.

Our company has designed several new fast mills, including the fastest mill now in operation, and modestly admits pride in having collaborated with personnel of several plants towards modernizing and speeding up several existing mills of obsolete vintage; and has witnessed already, the successful operation of these units in their daily production, exceeding anything of the past.

Where unprecedented speeds were involved, either in new designs or revitalizing programs, the developments were not spontaneous, or impetuously decided. The progress was slow, methodical, and carefully planned and evaluated with the people whom we served. Bad guesses cannot be tolerated in this business. The design of the following mills is described in the paper.

I. A 7200 fpm, two-stand tandem tin temper mill.

II. Fast aluminum foil mills.

III. A 1500-fpm reversing brass mill.

Speed is not the total answer or a panaca to all production ailments, but is certainly not to be overlooked in any search for the best solution. In many cases, it may have merit, or even be the only solution to sluggish production.

One final point to be emphasized, however, is that we, or no one else, have not yet figured out how to deny energy its full dues; at high or slow speeds, any given unit volume of metal displaced, regardless of process, takes so much horsepower to achieve, and whether done in one hour or one hundred hours, the energy consumed is the same per ton of steel processed.

"THE ADJUSTABLE VOLTAGE ORE BRIDGE DRIVE AT OTIS WORKS"

by CLARK B. RISLER, Industry Engineer, Westinghouse Electric Corp., East Pittsburgh, Pa., and E. C. JUHNKE, Electrical Engineer, Otis Works, Jones & Laughlin Steel Corp., Cleveland, Ohio

▲ THE steel mill industry for the past several years has been involved in a general expansion program to increase and at the same time improve their production facilities. One phase of this expansion program in the Jones & Laughlin organization involved increased facilities at their Otis Works. There, one requirement

was an increase in both the storage capacity and the unloading capacity at the ore yard.

This has been met by the installation of a modern ore bridge with a capacity of 17 net tons capable of unloading and placing into storage at the center of the yard 1040 tons per hour. This bridge is now working alongside an existing ore bridge of lesser capacity and two steam driven unloading towers.

The electrical equipment driving the new ore bridge features adjustable voltage drives for the hold, close and trolley travel motion. These were installed in order to make the best use of the available 4160-volt, 3-phase, 60-cycle a-c power supply. The drives feature the use of standardized mill motors, and the maximum duplication of electrical equipment. The multiple advantages of reduced weight, reduced power consumption, reduced inertia, improved accelerating characteristics and reduced maintenance have all been secured.

The bridge travel drives, the apron hoist and the turn table are driven by constant potential direct current secured from a constant potential generator on the main motor-generator set. Repair hoists, ventilating equipment, light and heat are supplied from auxiliary alternating current supplied by a power center installed in the machinery house.

A novel control system permits one master switch to control the vertical position of the bucket while a second master switch controls the opening and closing of the bucket under all conditions. This system was installed to permit the maximum flexibility in bucket operation and at the same time permit the ready transfer of operators from the existing rig to the new equipment.

Oscillograph records taken on the new bridge demonstrate the extent to which the driving equipment meets the desired ore handling requirements.

"MODERN LIGHTING SYSTEMS FOR STEEL MILLS"

by R. F. VANDENBOOM, Illuminating Engineer, General Electric Co., Cleveland, Ohio, and D. L. BEEMAN, Manager, Industrial Power Engineering, Industrial Engineering Department, General Electric Co., Schenectady, N. Y.

▲ THE choice of a lighting system for a particular area depends primarily upon the nature of the visual tasks performed in the area. Both filament and mercury lamps are used individually in areas where mounting height exceeds 20 ft, while a combination of these light sources produces adequate safety with reasonable color rendition.

Maintenance of lighting has always been a problem in steel mills. So-called "dust-tight" units, reflectors with properly designed ventilations or the use of the new high-bay industrial reflector lamps—either filament or mercury—are outstanding examples of lighting equipment that reduces maintenance. Group replacement of fluorescent or filament lamps also lessens the maintenance problem by decreasing labor costs.

Current minimum recommendations for illumination levels in steel mills vary from 10 footcandles for rough operations such as billet, blooming and hot strip mills to 300 footcandles in repair shops requiring extra fine work.

With the ultimate goal of more comfort through better quality, there is under way a movement which is revolutionizing industrial lighting. Many new reflector designs have been developed by lighting fixture manufacturers—particularly in the fluorescent field. Equipment is now available which provides an ample upward component of light output together with better shielding. At the same time, dirt accumulation may be actually reduced. By providing these new features economically, this revolutionary movement is giving the factory worker the same kind of eye comfort considered necessary for the office workers and school children.

With the increased use of gaseous discharge lamps, it is now possible to use higher than 120 volts to supply these lamps when used for general area lighting. Considerable savings in the cost of the lighting distribution systems can be obtained by combining light and power on the same 480-volt substation. Still more money can be saved by using 480Y/277-volt combined light and power substations and operating all mercury or fluorescent lamp ballasts line-to-neutral (i.e. at 277 volts) off the 480Y/277-volt system. Adequate short-circuit protection and switching equipment are available for these higher voltage lighting circuits.

Certain precautions are necessary when supplying power and lighting off the same substation. For instance, the power load should not produce undesirable flicker of the lights. By using modern system design these problems can usually be easily overcome.

"PROTECTION OF UNDERGROUND CABLE SHEATHS"

by T. W. ALEXANDER, Jr., Transmission Engineer, The Bell Telephone Co. of Pennsylvania, Pittsburgh, Pa.

▲ THIS paper deals with the protection of underground cable sheath against corrosion. It describes briefly the various types of corrosion usually encountered, dividing them into two general types known as stray current and non-stray current types. Stray current corrosion is due to electric current originating in electric street railway systems or in direct current generating systems in industrial plants. These currents stray from their normal path to the underground cable sheath and, if not properly taken care of, cause cable sheath corrosion. Non-stray currents, resulting from natural phenomena in the earth, also cause cable sheath corrosion.

Methods for combating corrosion in cable plant are discussed including forced drainage or cathodic protection. This type of protection makes use of a separate source of electric current to counteract the effect of the stray current.

The discussion also covers the methods used to determine where remedial measures may be necessary and stresses the importance of careful engineering in

the selection of routes for underground cables. It also emphasizes the importance of notification to other parties maintaining sub-surface structures in the area under consideration when any work is being done which may affect the other structures. It also emphasizes the desirability for close cooperation among all parties who have underground plant in any given area.

"SAFE HANDLING OF FUELS, HAZARDOUS GASES AND LIQUIDS"

by F. R. PULLEN, Fuel Engineer, Bethlehem Steel Co., Johnstown, Pa.

▲ FUELS and other hazardous gases and liquids can be handled safely when the work is planned, supervised and performed by properly trained men using tools designed for the particular job involved. The planning for the safe handling of these gases and liquids begins with the plant engineering department. Consideration of the hazards involved, as well the needs of the operation, often dictates the location of the pipe lines or vessels, the type of materials to be used in their construction, shut-off points, safety controls and warning devices, purging facilities and even building construction details. All too frequently the engineering details of this problem are neglected or passed over lightly and as a result additional hazards are introduced.

A planned program for the training of supervisors and workers is essential in the elimination of accidents in this type of work. Such a program should be maintained and carried out on a regular and permanent basis. The program would include technical education and instruction as well as scheduled training and practice in the use of approved protective equipment. Maximum plant coverage is necessary to acquaint each man with the general principles required to protect himself and fellow workers against the hazards involved from exposure to toxic, inflammable and chemically active gases or liquids.

"THE CHARACTERISTICS OF FUEL OILS USED IN THE STEEL INDUSTRY"

by JOHN P. CRITCHLOW, Chief Fuels and Lubricants Engineer, Rolling Mill Section, Gulf Oil Corp., Pittsburgh, Pa.

▲ THIS paper covers the characteristics of fuel oils recovered from various types of crude oil with the emphasis on residual oils and the sulphur content thereof. The characteristics of crude oils from various parts of the world and their effect on residual oils are discussed as are the various refining processes and their effects on the residual fuels. This phase of the paper should help to clarify the reasons for the wide variation in sulphur content found in residual oils.

The writer also presents the economic side of the residual fuel oil picture and how it affects the possibility of reducing the sulphur content in such fuels now and in the future.

"THE PUMPING AND BURNING OF TAR AND PITCH"

by WARREN A. POND, Manager of Industrial Viscous Fluid Department, Fluid Systems, Inc., New Haven, Conn.

▲ THE author discusses the advantages of pitch in an open hearth furnace. That the pitch may be solid at room temperature does not appear as a serious obstacle. "Toppings" of 20 per cent and more are held to be reasonable. Design of both pumps and burners are shown to be far enough advanced to permit the use of pitch as a fuel over a wide range of temperatures and viscosities. The way to the determination of the most favorable temperature is indicated. The importance of the transmission system is emphasized. Maxima in reliability and overall economy in operation are claimed for such a system, and minima in temperature gradients anywhere along the line, cost of insulation and maintenance are also claimed. Operating temperatures are quickly adjustable over a wide range to assure constant viscosity despite variability in the pitch. The system may be started up after long shutdowns without blowing out the line.

Be Sure to Attend the . . . .

1952 IRON AND STEEL EXPOSITION AND ANNUAL CONVENTION OF THE AISE

CLEVELAND PUBLIC AUDITORIUM
CLEVELAND, OHIO

SEPTEMBER 30, OCTOBER 1, 2, 3

A-C POWER DISTRIBUTION

. . . . the best steel plant power system is that which incorporates simplicity in design and reliability in equipment . . . .

▲ THE electrification of steel mills had placed unprecedented loads upon steel mill a-c power systems. Not only has the magnitude of these loads increased, but as the extent to which electricity becomes the prime source of power for operation of the plant, the demand for higher quality electric service increases. General improvement in power system engineering has enabled the designing of power systems to carry these larger loads economically and with greatly improved quality of service. Improvements in power distribution system components, i.e. switchgear, cable, substations, transformers, bus, etc., have made possible the attainment of better, simpler systems.

The field of power distribution in steel mills is a broad one, covering low-voltage a-c circuits (600 volts and less), primary a-c circuits (2.4 kv and above), and d-c circuits. Each one of these areas could be the subject of a complete paper. In the interest of brevity, primary a-c power distribution systems will be the main area of consideration in this paper.

NATURE OF STEEL MILL LOADS

Electric power loads in steel mills are characterized by being very large, and concentrated mainly in a few areas such as at mill drives. Because of the intermittent nature of metal rolling, the loads are subject to heavy swings at relatively frequent intervals.

In view of these characteristics, the power distribution system to supply steel mill loads must, of necessity, be of large kva capacity, to transmit bulk power from the source to a relatively few load centers and be stiff enough to take the large load swings without undue voltage variation. Of particular concern in this paper are the larger integrated steel mills of the order of about 50,000 kva demand or more.

SELECTION OF SYSTEM VOLTAGE

One of the first and foremost problems in designing a new, or expanding an old, steel mill power distribution system is the selection of voltages for primary power generation, transmission, distribution and large motors. Since large motors represent a sizable portion of the total load, let us look first at them. In general two voltage levels are suitable for these motors, i.e. 6600 volts (6900 volt system) or 11.0 - 13.2 kv (11.5 - 13.8 kv system). To simplify the reference to the higher voltages where 13.2 kv motors or 13.8 kv systems are mentioned, it will be assumed that the ranges 11.0 - 13.2 kv for motor ratings and 11.5 to 13.8 kv for system ratings are referred to.

A fundamental principle of selecting power system voltage is that, in general, the higher the voltage in a given class, such as the 13.8 kv vs 6.9 kv in the 15 kv class, 4.16 kv vs 2.4 kv in the 5 kv class, the lower the system cost. In steel mills there are many large motors which operate at either 6.9 kv or 13.8 kv. Hence, in choosing voltages in this class, 6.9 kv is often thought to offer a less expensive system because:

1. The large motors cost $1.50 to $2.00 per horsepower less at 6.6 kva than at 13.2 kv.
2. From an electrical standpoint more satisfactory designs of smaller motors (less than about 2000 hp) can be made at 6.6 kv than at 13.2 kv.

UTILIZATION VOLTAGES

The problem of satisfactory designs of smaller motors (under about 2000 hp) loses its significance when the over-all utilization voltage picture is looked at critically. Other studies show that an intermediate voltage in the 5-kv class is desirable for medium sized motors too large for the 600-volt class systems and too small for the 13.8 kv class systems. When this intermediate voltage is adopted, the line-up looks like that shown in Table I.

TABLE I

Steel Mill Utilization Voltages

Motor voltage	Horsepower range	System voltage
440	Up to 200-500	480
2,300	200-2000	*2,400
6,600	Above 1000-2000	6,900
13,200	Above 2000	13,800

*2400 volt systems are referred to here rather than 4160 volt systems because this is really a voltage for supplying only local motors and not for extensive distribution of power. Hence there are generally not sufficient distribution systems savings at 4160 volts to pay for the extra cost of 4000-volt motors.

When a 13.8-kv system is used, the intermediate voltage is essential to care for those motors in the 200 - 2000 hp range. This, however, does not represent an economic penalty on the 13.8 kv system because the intermediate voltage is desirable from an economic standpoint as well as from a motor design standpoint

IN STEEL PLANTS

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to cover the range of 200 to 1000-2000 hp in 6.9-kv systems. In the smaller horsepower ratings, for example under about 1000 hp, a 6.6-kv motor and starter costs as much or more than 6.9 - 2.4-kv transformer capacity, 2.3-kv motor and starter. The intermediate voltage provides greater flexibility of system design and motors more suitable from a voltage rating standpoint may be used. For example, small 6.6-kv motors, which are not as satisfactory from an electrical standpoint as 2.3-kv motors, need not be put on 6.9-kv systems because they are too big for 600 volt systems.

With the intermediate voltage in the picture, it works out that so far as utilization equipment voltage rating is concerned, the only economic penalty of the 13.8-kv system is the $1.50 - $2.00 per horsepower higher cost of the larger mill motors above about 2000 hp. An inclusion of the figures for detailed substantiation of the foregoing is beyond the scope of the paper.

13.8 VS 6.9-KV POWER DISTRIBUTION SYSTEMS

Let us now look at the power distribution system and compare 13.8 kv vs 6.9 kv and see if there is enough difference in cost between 13.8 kv and 6.9 kv to pay for the extra cost of the larger 13.2-kv mill motors. First, a general comparison of the basic system components of the power system, i.e. transformers, switchgear, unit substations, cable and bus, is given in Table II.

TABLE II

System Component Cost Comparisons

System component	Comparative unit costs	
	13.8 kv	6.9 kv
Transformers (large power)	About same per kva.	
Metal-clad switchgear		Slightly more per position of same amp ratings.
Cable and bus		+$0.25 to $0.65 per kva per M ft more.
Turbine generators above 10,000 kw	Same per kva.	
Load center unit substations stepping down to 2.4 kv or 600 volts	$0.40 to $1.00 per kva more.	

Examination of Table II indicates that one would not expect a wide difference in cost per kva of 13.8 kv and 6.9 kv systems, because there are many items which are substantially the same regardless of system voltage and of the other items some are more expensive for one voltage and some for the other voltage.

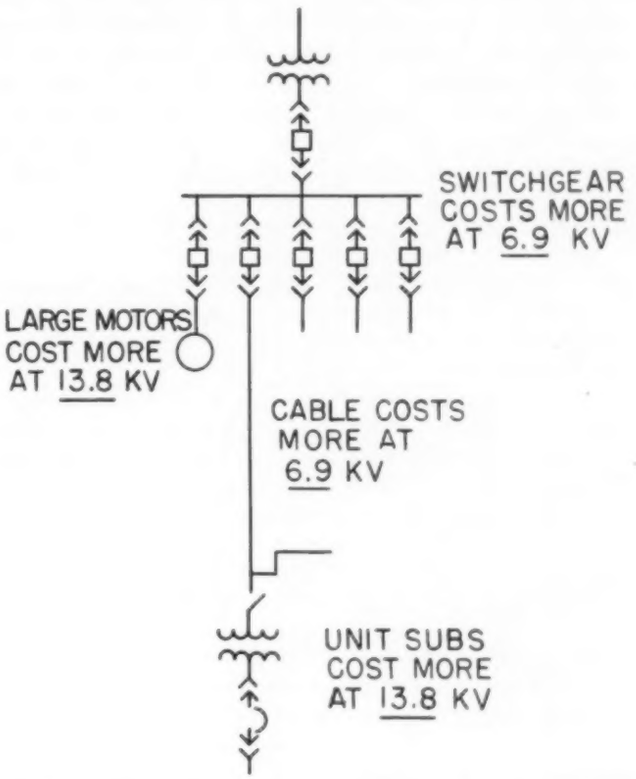


Figure 1 — Small systems have about the same cost at 6.9 or 13.8 kv.

13.8 VS 6.9-KV IN SMALL POWER SYSTEMS

In small systems of about twenty-thousand kva or less, Figure 1, there is little if any economic penalty of 6.9 kv vs 13.8 kv. In these systems short-circuit duties are low and metal-clad switchgear with removable breakers may be used. In metal-clad switchgear interrupting ratings are the same for both voltages and there is only a very small extra cost for 6.9-kv switchgear. In general, in these systems 1200-amp circuit breakers are adequate for continuous current-carrying duty because small feeder circuits go with smaller plants. More copper but less insulation is required for 6.9-kv cable than

for 13.8-kv cable. The price differential for cable also is small. In these smaller plants, the lower cost of 6900-480-volt substations plus the extra cost of any 6.6-kv motors more than offset the higher cost of switchgear and cable so that there would be little cost difference between the two voltages. If an appreciable portion of the power in these smaller systems is used in large motors (over 2000 hp), then there may be a saving at 6.9 kv, depending upon the circuit lengths involved.

13.8 VS 6.9-KV IN LARGER POWER SYSTEMS

Effect of larger circuits — As systems grow larger there are factors that begin to increase the cost of 6.9-kv systems much faster than for 13.8 kv systems. For example, where single source unit or feeder ratings go above about 13,000 kva, 2000-amp circuit breakers are required at 6.9 kv while 1200-amp circuit breakers will carry about 26,000 kva at 13.8 kv. With single source units above about 21,500 kva, multiple breakers or station type switchgear with continuous current ratings above 2000 amperes must be used at 6.9 kv where a 2000-amp breaker will carry over 43,000 kva at 13.8 kv. To illustrate — suppose a source unit was rated 15,000 kva, requiring a 2000-amp metal-clad breaker position at 6.9 kv and only a 1200-amp metal-clad breaker position at 13.8 kv, the added cost of the 6.9 kv system for the increased current rating of this one breaker alone would be about 25¢ per kva. This cost differential is small but it is merely the beginning of a trend toward higher system cost at 6.9 kv. Other items will greatly increase this differential as is seen in the following.

As systems become larger, more and more circuits are required where 2000-amp breakers would be needed at 6.9 kv instead of 1200-amp breakers at 13.8 kv. Typical of one of these larger systems is Figure 2. As explained later, the synchronizing bus is required to limit short-circuit currents in these larger systems. In Figure 2 all breakers marked "A" would be rated 2000-amp at 6.9 kv. The others would be rated 1200-amp at 6.9 kv. All of these breakers would be rated 1200-amp at 13.8 kv. The synchronizing bus and reactors are rated 2000-amp at 6.9 kv vs 1200-amp at 13.8 kv. These items further increase the spread in cost in favor of the 13.8 kv system. On the basis of the circuits and their ratings shown in Figure 2, the 6.9 kv system costs about $1.00 per kva more than the 13.8 kv system for switchgear, synchronizing and bus reactors only. This alone nearly pays for the extra motor and step-down unit substation costs at 13.8 kv.

In large systems, cable or circuit costs go up rapidly at 6.9 kv. As stated previously, circuit costs for small single-cable circuits are not much more expensive than 13.8 kv circuits. However, in large circuits of several thousand kva each, when more than one conductor per phase is required, circuits cost about two-thirds more per kva per 1000 ft at 6.9 kv than at 13.8 kv. For interlocked armor cable this differential runs up to about 65¢ per kva per 1000 ft. This makes large 6.9 kv systems proportionally more expensive than large 13.8 kv systems.

If, in Figure 2, cable costs average 50¢ more per 1000 feet per kva at 6.9 kv than at 13.8 kv, and the average length of cable circuit is 2000 feet, then this adds another $1.00 per kva to the system cost. This $1.00 per kva plus the $1.00 per kva extra for powerhouse switchgear, synchronizing bus and reactors, more than pays the cost of the higher voltage load-center substation and the larger motors in steel mill systems of medium size, up to about 40,000-kva demand in this case. There are additional savings in the 13.8-kv switchgear and cable circuits in the mill area.

Effect of Higher Short-Circuit Duty — So long as short-circuit duties are under the momentary ratings associated with 500 mva magne-blast circuit breakers there is no significant difference in the circuit arrangement of number of circuit components required to care for short-circuit currents whether the voltage be 6.9 kv or 13.8. However, since momentary currents are usually the most limiting factor in applying power circuit breakers in steel mill power systems, using the steel mill type 60,000-amp momentary, 500-mva, 13.8-kv metal-clad switchgear enables slightly larger systems to be built before synchronizing buses are required than does the 70,000-amp, 7.2-kv, 500-mva breakers. The reason is that the maximum ampere interrupting rating of a 500-mva, 7.2-kv circuit breaker is 44,000 amperes and the maximum momentary rating is 70,000 or about 1.6 times the maximum interrupting rating amperes. There is only enough to care for the d-c component in 6.9 kv systems. The maximum ampere interrupting rating of the 13.8-kv, 500-mva steel mill magne-blast circuit breaker is 25,000 amperes while the momentary rating is 60,000 amps or 2.4 times the maximum ampere interrupting rating. Since a momentary rating of only 1.6 times the maximum ampere interrupting rating is required to care for the d-c component in 13.8-kv systems, the extra difference between 1.6 and 2.4 is available to care for motor contribution. Hence, these circuit breakers can be used in steel mills to the full interrupting rating whereas 6.9-kv, 70,000-amp momentary breakers usually cannot.

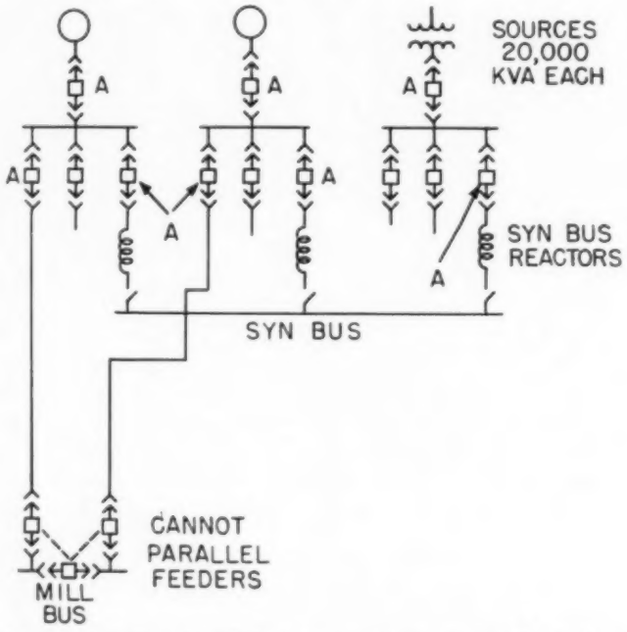


Figure 2 — Synchronizing bus system in medium sized steel mill. 6.9 kv costs more than 13.8 kv.

As systems become still larger and short-circuit duties increase to a point above the momentary rating of 500-mva metal-clad magne-blast circuit breakers, then the synchronizing bus arrangements mentioned previously, Figure 2, are required. Synchronizing bus arrangements, while workable and often used for keeping short circuits within bounds, do have certain limitations. One of the disadvantages is that the kvar transfer between bus sections must be made through reactors. Any transfer of kilowatts through the reactors represents a small I^2R loss too. When one source unit is out of service, all load from that bus section must be fed through a reactor with the attendant voltage drop. The synchronizing bus arrangement imposes circuit design and operating restrictions too. For example, feeders from different bus sections cannot be paralleled because this will short out the synchronizing bus reactors, Figure 2, and increase short-circuit duties on the system.

Aside from those points there are definite limits in the synchronizing bus system, in the relationship between the size of the source unit and the interrupting rating of circuit breakers.

For example, when using 500-mva switchgear, the largest source unit per bus section is limited to about 25,000 kva. Generators and main transformers for large steel mills now very often run larger than this.

When the limits of the synchronizing bus scheme, using the lower cost metal-clad switchgear with 500-mva maximum interrupting duty, are exceeded, or where it is desired to operate with as many source units as possible on one bus to allow more freedom of system operation and design, higher interrupting capacity station type switchgear must be used. Station type switchgear breakers available for higher duty on 15-kv class systems are all rated 14.4 kv and may be used to nearly full kva interrupting rating at 13.8 kv without exceeding their momentary ratings in circuits with reasonable motor short-circuit current contribution. These breakers, however, can only be used to part of their interrupting rating at 6.9 kv because of momentary and maximum interrupting current rating limitations. This can be seen by referring to Table III.

TABLE III

Station Type Breaker Interrupting Ratings at 13.8 Kv and 6.9 Kv

Breaker rating	Momentary rating, amp	Interrupting rating, mva	
		At 13.8 kv	At 6.9 kv
ARA-14.4-1000	77,000	1000	575
ARA-14.4-1500	115,000	1500	860
ARA-14.4-2500	190,000	2500	1440

Using a 1000-mva station type breaker at 13.8 kv enables nearly doubling the capacity per bus compared with using 500-mva magne-blast type metal-clad switchgear, but at 6.9 kv only enables an increase of capacity per bus of 75 mva or 15 per cent. Even using the 1500-mva switchgear does not enable doubling the bus capacity compared with metal-clad switchgear at 6.9 kv. Only by going to the 2500-mva breaker can any real gain be made at 6.9 kv. It is interesting to note the relative cost per mva of interrupting duty of these various breakers.

TABLE IV

Approximate Cost of Metal Enclosed Switchgear per Mva per Breaker Position

Breaker designation	Approximate cost per Mva *(IR)	
	At 13.8 kv	At 6.9 kv
AM-13.8-500	$16	$16+
ARA-14.4-1000	$16	$28
ARA-14.4-1500	$16	$28
ARA-14.4-2500	$22	$38

*Interrupting rating.

From Table IV it is seen that for larger systems the cost of switchgear increases to almost twice as much at 6.9 kv as at 13.8 kv on the basis of dollars per mva of interrupting duty.

OVER-ALL SYSTEM COST DIFFERENCES

Figure 3 has been chosen to illustrate the difference in cost between 6.9 kv and 13.8 kv on a system basis for large systems of the order of 100,000 kva capacity. Table V gives the detailed ratings of switchgear and circuits. These have the same sources and same loads, the difference being in voltage only.

TABLE V

Ratings of Equipment in Figure 3

Item	13.8 kv	6.9 kv
Switchgear station type.	1500 mva	2500 mva
Cable circuits, Each cable 3-conductor — 500 mcm	4 per circuit	8 per circuit
Cost difference		+$12.00 per kva
Less cost difference of substations and motor		— 1.50
Total difference		$10.50 per kva

It is not intended that this example represent precisely any particular steel mill, but it is designed to bring out the difference in cost of the two voltages. For the entire power system down to, but not including, the step-down substations and load equipment, the difference in favor of 13.8 kv is $12.00 per kva. From this must be subtracted the extra cost of 13.8 kv step-down substations and 13.8 kv large motors. This will be about $1.50 per system kva, leaving $10.50 per kva of total system capacity in favor of the 13.8 kv system. That is real money!

The 6.9-kv system could be redesigned, using a synchronizing bus arrangement, to reduce the interrupting duty to 846 mva, using the lower priced ARA-14.4 - 1500 breakers in all but the 50 mva generator

position. This reduces the cost differential only slightly, about $1.00 to $2.50 per kva, but adds greatly to the complication of system design and operation and requires more circuit breakers, reactors, etc., hence more space and a larger powerhouse room for the switchgear. Besides it adds the aforementioned disadvantages of the synchronizing bus system. Hence, it can be concluded that for any steel mill total plant loads above about 30,000 - 40,000 kva, 6.9-kv systems are considerably more expensive and more complicated than 13.8-kv systems.

CIRCUIT LAYOUT OF LARGE 13.8 KV SYSTEMS

In designing large 13.8-kv systems there are certain fundamental principles which, if followed, will result in a simpler, lower cost and easier to operate system. In these large systems it is, as stated previously, desirable not to use synchronizing buses if it can be avoided. Where, because of the large source units and loads involved, station type switchgear will be required, it is desirable to choose 1500 mva instead of the 1000 mva interrupting duty switchgear as that allows for more expansion of the system before having to go to a synchronizing bus system. As shown in Figure 3, as many of the source units as feasible should be put on one bus providing the short-circuit duties do not go above the rating of the 1500-mva switchgear. When the 1500-mva switchgear is used, a total system capacity of over 100 mva can be connected to one 13.8-kv bus

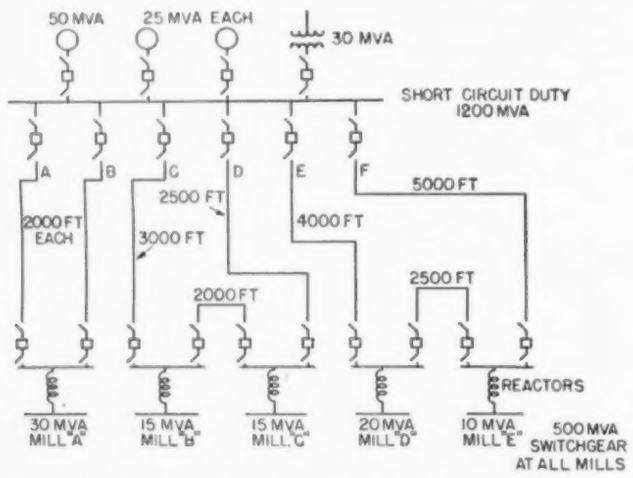


Figure 3 — Diagram of power system for large steel mill used as basis of comparison of 6.9 vs 13.8 kv for large systems.

without exceeding the momentary rating of 1500 mva station type switchgear. The basic power transmission system to the mill buses, whether parallel feeders like feeders "A" and "B," Figure 3, or loop feeders like feeders "C" to "F," Figure 3, should be stiff enough so that the large fluctuations in load caused by mill operation will not cause undue voltage variation in the system.

Reactors will be required to reduce the short-circuit duty to 500 mva to permit the application of 500-mva magne-blast type metal-clad switchgear in the mill motor rooms and in the process areas. By placing the reactors at the mill motor rooms, as shown in Figure 3, the voltage drop through the reactor does not affect the entire system. Furthermore the per cent voltage drop is reduced because the reactor ohms are determined by the short-circuit duty and not by the load. The required ohms in the reactor are constant regardless of the size of the load, because the short-circuit duty must in every case be reduced from 1500 mva to 500 mva. Hence, with constant ohms the smaller the load that goes through the reactor, the smaller will be the voltage variation.

USE OF SYSTEM VOLTAGES ABOVE 15 KV CLASS

Systems of the type shown in Figure 3 can be used to economically and satisfactorily handle very large steel mill loads. There are, however, conditions which make even higher voltages economically attractive.

When transmission voltages above 15 kv are used, such voltages cannot be generated directly or used directly on motors. Hence, transformation up from generator voltage and down to a voltage suitable for large motors is required. This adds one or two steps of power transformation, not required with the 13.8-kv system shown in Figure 3, at an extra cost of $5.00 to $10.00 per system kva. Therefore, the higher transmission voltage must save in circuit and switchgear costs more than the extra cost of the transformers to be economically justified over the system of Figure 3. Only when long distances or very large loads are involved can the circuit savings and switchgear savings overcome the cost of the double transformation. There are many practical steel mill systems in which voltages higher than 13.8 kv are used.

SELECTION OF TRANSMISSION VOLTAGE ABOVE 15 KV

There are, in general, four voltages which have been used for this service. These are 23 kv, 34.5 kv, 46 kv, and 69 kv.

Again these voltages will be divided into two classes, i.e. the 34.5-kv class which will include both 23-kv and 34.5 kv and the other the 69-kv class which will include 46 kv and 69 kv.

The major advantage of 34.5-kv distribution system for very large systems is that compact indoor 34.5-kv station type metal-clad switchgear may be employed for switching the main power circuits. In addition to occupying less space and being indoors, such metal-enclosed switchgear eliminates the problems associated with cleaning so many exposed insulators as are found in the outdoor stations normally employed at this voltage.

Where space for locating substations is no serious limitation and the insulator cleaning problem is not considered a major obstacle, larger, simpler systems can be built for lower cost at 69 kv. The 69-kv system requires fewer circuits where there is bulk transmission of large amounts of power from one point to the other.

Thus, in general, when voltages above 15 kv are selected, a maximum of 34.5 kv would be used where metal-enclosed switchgear in indoor substations is desired and some higher voltage like 69 kv where open switching stations can be employed.

There will obviously be many other local factors such

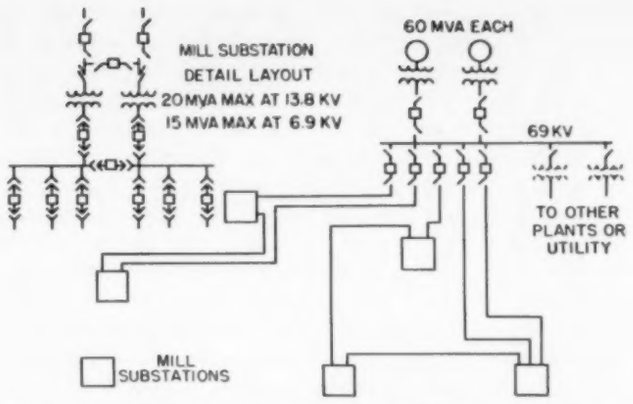


Figure 4 — Large steel mill using high-voltage transmission and load center distribution system.

as utility supply voltage, voltages already available in the mill, kva demand of mill, distances, etc., which will have a significant bearing on the selection of 34.5 kv vs 69 kv for a particular steel mill. Such detailed discussion is beyond the scope of this paper.

USE OF THE LOAD CENTER PRINCIPLE

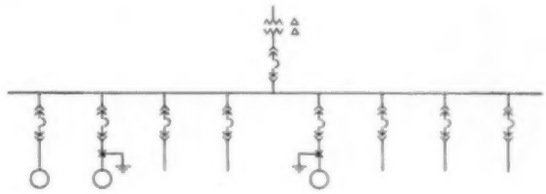
When these higher primary voltages (above 15 kv) are used, the load center principle may be employed to reduce the cost of these systems. The load center principle involves primarily taking the power at 34.5 kv or 69 kv to the load areas and there stepping it down to utilization voltage. In this case the step-down substation supplying individual load centers or mill areas should have maximum kva rating of about 30,000 to 40,000 kva per 6.9 or 13.8-kv utilization bus and a maximum kva rating per single three-phase transformers of about 15,000 to 20,000 kva each to limit the short-circuit duty to within the ability of 500-mva metal-clad switchgear. Such stations can be duplicated at various load centers in the mill. Figure 4 is a one-line schematic diagram of such a system. Included in Figure 4 is a detailed diagram of one substation.

In the load center system employing higher primary primary voltage, 6.9 or 13.8 kv are merely utilization voltages without extensive distribution systems or large source units at these voltages. Because there is no extensive distribution system at these voltages to offset the high cost of 13.8-kv large motors, it is often less expensive to use 6.9 kv rather than 13.8 kv for the utilization voltage in these load center systems. Also 6.9 kv may be particularly desirable when that voltage is already established in a mill.

GROUNDING

There are two types of grounding, both of which are extremely important to the successful operation of steel mills. The first is system neutral grounding which involves connecting the system neutral to ground. The second is equipment grounding which involves connecting the frames of all electrical apparatus solidly to a ground bus.

System neutral grounding has become more and more prominent in steel mill power systems because it improves service reliability and reduces maintenance and operating cost. Experiences with ungrounded neutral systems, particularly the 6900-volt class systems, have been rather disastrous in many cases. There have been



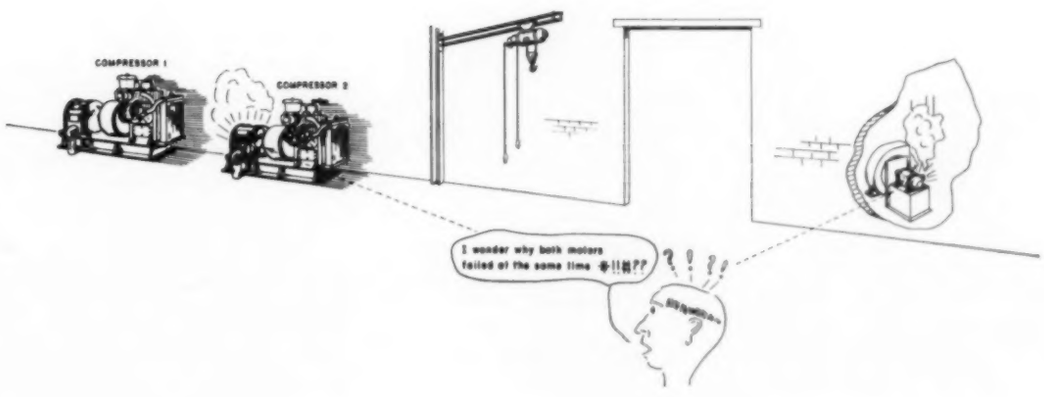


Figure 5 — Possible effect of one restriking ground fault on an ungrounded system causing simultaneous ground faults in other connected apparatus.

line-to-ground faults on the ungrounded neutral systems which have set up high transient voltages which have caused multiple failures, thereby taking two or more pieces of apparatus out of service at a time, Figure 5. Even though a single line-to-ground fault may not cause an immediate trip-out of a piece of equipment, there is very apt to be a restriking fault to ground. This sets up high transient voltages, damaging insulation at other points and thereby producing many weak spots in the insulation so that the number of ground faults following the restriking ground fault is greatly increased over what it would be if the system neutral were properly grounded. In grounded neutral systems, these transient voltages are reduced to very low values and therefore multiple failures are rare and severe damage to insulation, causing weak spots, is practically eliminated. Experience with systems which have been ungrounded neutral and later grounded at the neutral have shown a rapidly decreasing number of ground faults immediately after grounding the neutral. Eventually the number of ground faults is very greatly reduced because of system neutral grounding. Hence, the service reliability of the system is improved.

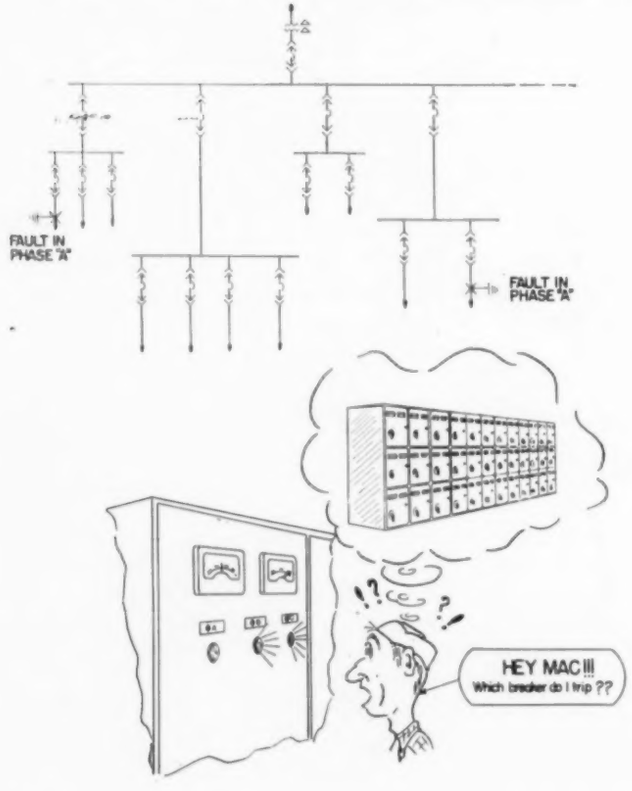
Properly grounding the system neutral also enables finding the ground faults more easily. When a ground fault occurs in an ungrounded neutral system, ground indicators will indicate that such a fault is on the system but will not tell where it is, Figure 6. Experience has shown that if the first ground fault is not removed promptly, the restriking faults mentioned previously may cause a second ground fault before the first one is located, Figure 7. Also it causes the damage to insulation mentioned previously. If the ground faults are to be removed immediately, then it is necessary in an ungrounded neutral system to take the system out of service a circuit at a time until the ground fault is located. This costs money and may mean much more of a system outage than in a grounded neutral system where the part affected, and only the part affected, is immediately tripped out. No time is spent looking for ground faults in grounded neutral systems and repairs can be made quickly and the equipment placed back in service without injurious damage to the rest of the system.

For systems in the 600-volt class such as 480-volt systems, grounding at the neutral is becoming more and more common for the same reasons as are mentioned above, i.e. to decrease maintenance and operating cost and to increase service reliability. At the present time about a third of the load center unit substations are sold for grounded neutral systems.

In systems 2.4 to 13.8 kv, it is common practice to use resistance neutral grounding of the system neutral to enable selective relay operation, yet to reduce the burning in rotating machines usually operated at these voltages. Experience has shown that when resistance neutral grounding is used to reduce the ground fault current, severe burning of iron is practically eliminated because ground faults are quickly disconnected from the system. In systems above 15 kv, solid system neutral grounding is usually used to obtain better lightning protection as these circuits are generally of the open type and are exposed to lightning. Furthermore there are no rotating machines connected to these higher voltage circuits, therefore the advantages of limited ground fault current are not so pronounced as for the 2.4 to 15-kv class to which rotating machines are connected.

System neutral grounding at all system voltages from 120 volts to 69 kv or higher is an essential part of a modern steel mill power distribution system.

Figure 6 — Ground indicators will tell when a ground fault occurs on an ungrounded neutral system, but location of ground faults may be troublesome in such systems.



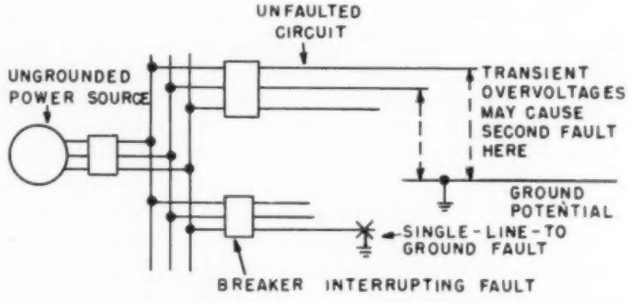


Figure 7 — Transient voltages during interrupting of line-to-ground fault on ungrounded systems.

EQUIPMENT GROUNDING

Equipment grounding is the connecting to earth of all noncurrent-carrying parts of electric machinery and equipment. This is essential for safety. It provides a low resistance path for ground currents so ground fault currents will not set up dangerous potentials in the building structures or on machine frames. A suggested

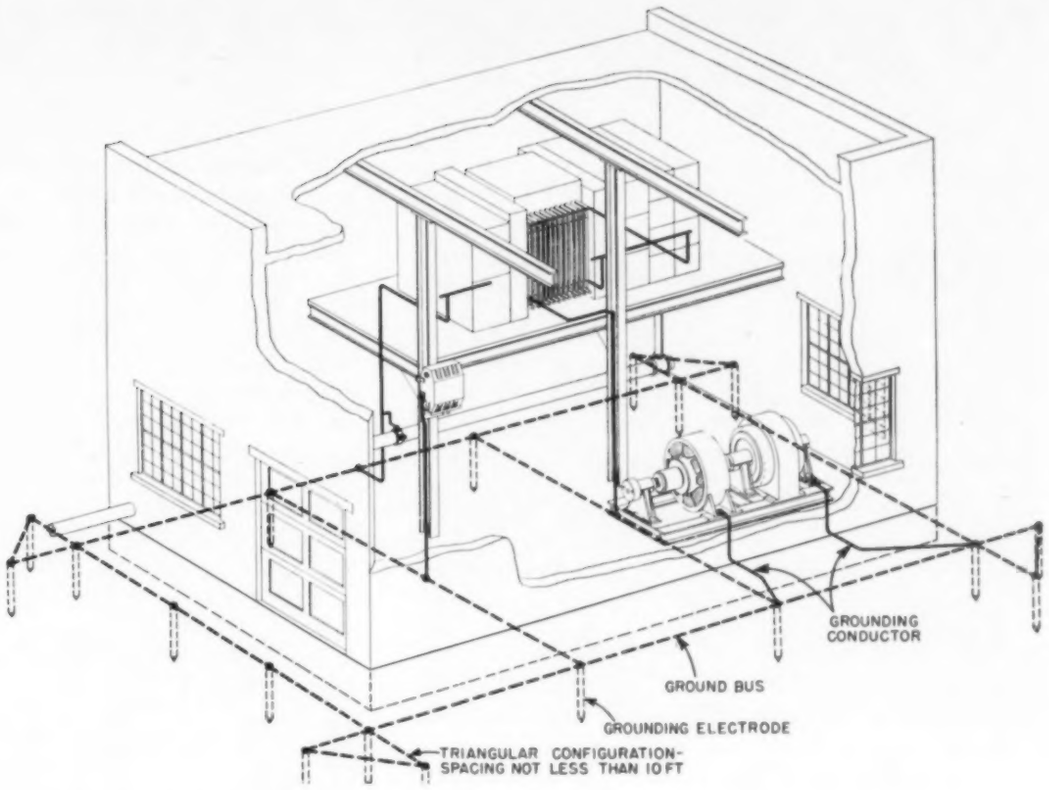


Figure 8 — Representative equipment for safely grounding an industrial plant.

equipment, or so-called safety grounding system, is shown in Figure 8.

VOLTAGE REGULATION

The problem of obtaining good voltage regulation or low voltage spread in a steel mill, or any other plant for that matter, is becoming more and more important. As electricity does more and more things, particularly of a process control nature, closer and closer voltage regulation is required. If voltage spreads are too wide, then electric power cannot perform its function satisfactorily and the quantity and quality of production are affected. In large steel mills which have interconnections with utilities, it is very desirable to provide maximum operating flexibility by having load ratio control in the transformers which connect with the utility to permit independent control of the voltage on the steel mill system and on the utility system. It also permits independent control of the power factor or kvar flow on the two systems. Large high-voltage utility systems to which steel mills are usually connected have to be operated for best over-all advantage of the utility so that they can vary the transmission voltage to permit transfer of large blocks of power from one part of the utility system to the other. On the other hand, the steel mill operators would like to maintain substantially constant bus voltage. These qualifications can only be met by having load ratio control or other means of voltage regulation between the utility and the steel mill power distribution system. The application of this type of voltage regulation is becoming more and more common in industrial plants.

There are many other system factors, such as lightning protection, power factor improvement, short-circuit protection, etc., which are all very important components of the modern steel mill power distribution system. However, space does not permit a complete discussion of all of these. Therefore, the remaining part of this paper will discuss some of the equipments, particularly the newer aspects of them that are used in modern a-c power steel mill power distribution systems.

EQUIPMENT FOR STEEL MILL POWER SYSTEMS

Switchgear — Switchgear is the heart of any power distribution system. It serves to switch as well as to protect the circuits and equipment.

There are three classes of switchgear available for primary distribution systems in steel mills. These are: first, metal-clad switchgear with readily removable breakers; second, the station type switchgear with stationary breakers and last, the open type structures for circuits above 15 kv.

Metal-Clad Switchgear with Readily Removable Breakers — Modern metal-clad switchgear, Figure 9, is familiar to all. As a matter of record, such switchgear now consists mainly of air type circuit breakers instead of oil circuit breakers. The air circuit breakers enable more operations, better performance, and there is no liquid to maintain and take care of. To permit more economical designs of steel mill power distribution systems, a 500-mva interrupting duty steel mill metal-clad breaker is available for 13.8-kv circuits with higher momentary rating than the standard 500-mva, 13.8 kv, ASA breaker. This steel mill breaker has a momentary rating of 60,000 amperes compared with 40,000 amperes for the ASA standard breaker. These breakers may be

used up to their full interrupting rating in practically every case without exceeding the momentary rating. In many cases while the duty at an initial installation may be less than 40,000 amperes — the momentary rating of the standard 500-mva, 13.8-kv breaker — the future addition of large motors may raise the momentary duty over 40,000 amperes before the 500-mva interrupting level is reached.

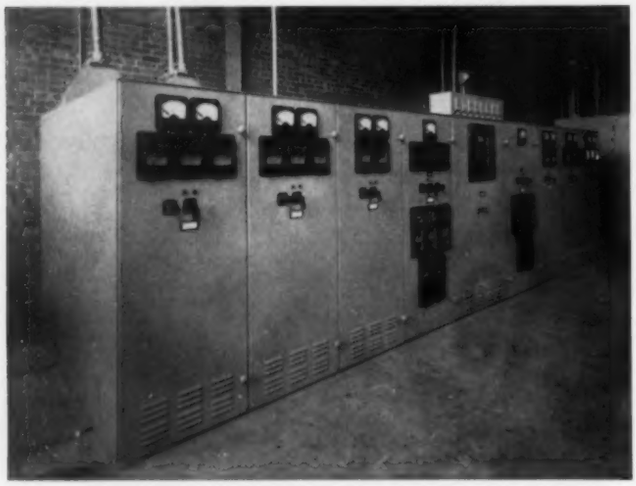


Figure 9 — Typical installation of metal-clad switchgear with magneblast air type power circuit breakers.

Station type Switchgear — Station type switchgear, Figure 10, is mainly for higher interrupting duty and is used primarily in power station main buses. It is applicable where large 13.8-kv systems, such as shown in Figure 3, are used. This switchgear is employed in the powerhouses and main supply substations, Figure 3. This switchgear is now available with air circuit breakers obtaining the same advantages as mentioned for metal-clad switchgear using air circuit breakers.

Outdoor Open Type Switching Stations — Outdoor open type switching stations consist of a steel structure, circuit breakers, disconnects, etc., assembled in the field. The significant trend in the design of this equipment has been the development of standardized steel structures, Figure 11. The use of these structures enables shorter shipment, quicker delivery of drawings and, in the long run, should result in lower over-all cost of the substations. The standard structure also reduces the amount of design work necessary by the field engineers, because the switching structure design work is already done by the factory.

Figure 10 — Typical installation of air blast circuit breaker cubicles having 1000-mva interrupting rating.

Package Substations — The factory assembled and engineered substations have, in the last ten years, mainly superseded field designed and constructed substations. These substations are now available for almost any industrial application. The package substation, as illustrated in Figure 12, consists of a high-voltage incoming line structure and 3-phase transformers stepping down to a voltage in the 15-kv class such as 6.9 or 13.8 kv. The metal-clad switchgear for control of the outgoing circuits is an integral part of this substation. Such substations are compact and are completely coordinated by the supplier. This relieves the purchaser of much detailed work in engineering and coordination. It also greatly simplifies ordering and procurement because only one order — usually just one catalog number — is necessary to order a package substation such as the one shown in Figure 12. These substations are particularly applicable to the load center type system where 69 or 34.5 kv are used as the primary voltage in the steel mill and that voltage is stepped down to utilization voltage at mill areas. One such substation could supply each load center, Figure 4, and could have a one-line diagram as shown in the upper left-hand corner of Figure 4.

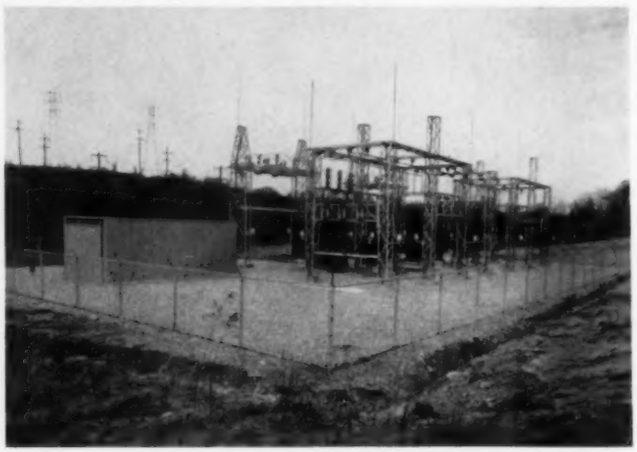


Figure 11 — Typical installation of outdoor switching station with standardized design steel structure.

These substations are particularly adaptable for supplying power to an entire smaller sized steel mill where power is delivered by the utility at voltages above 15 kv.

CABLE

An entire treatise could be prepared on cable. However, it will suffice here to mention the fact that interlocked armored cable affords a method of lowering the cost of cable circuits, particularly within the buildings, in steel mills. This cable can be installed on ladders as shown in Figures 13 and 14. Such cable is easy to install and it has a lower installed cost than cable in conduit. It is easy to change and re-route if necessary. It also provides complete freedom of access to the cable as it is available practically throughout its entire length for ready maintenance or change or connecting to.

Development of rubber-like compound insulated cables has been rapid in the last ten years. These cables

are now being used widely at 15 kv. They eliminate the necessity for potheads and are less subject to damage due to moisture than lead-covered cables. Lead-covered cables, of course, will keep out moisture so long as there are no holes in the lead but the presence of small holes admits moisture to the insulation and causes failure.

A gas-filled lead-covered cable is being used more and more, particularly for voltages 15 kv and above. The gas maintains a slight positive pressure in the cable which does two things, it improves the insulation quality and it acts as a supervising means to determine when there are holes in the cable. If a small hole does occur the positive pressure on the inside keeps the gas flowing out and therefore keeps moisture out of the

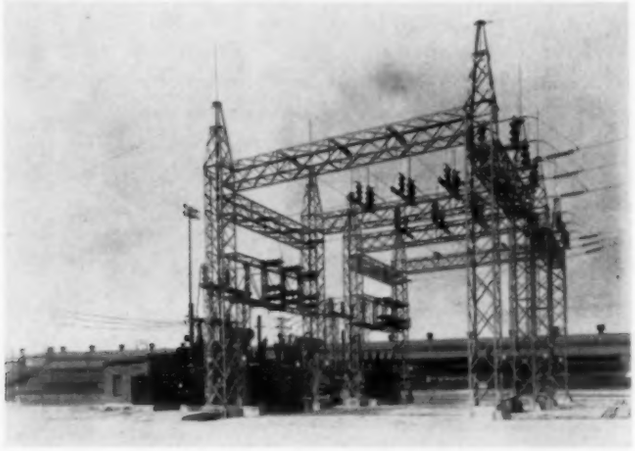


Figure 12 — Outdoor package substation 30,000/50,000 kva, 115-13.8 kv has two incoming lines and five outgoing feeder circuits. It is installed at an eastern steel mill.

cable. When this gas flows out through a leak in the sheath, the gas usage increases which indicates to the operator that there is a hole in the cable sheath. That leak can be hunted down at a convenient time and the repair made in many cases before a fault results and inadvertently takes the cable out of service.

SUMMARY

While great strides have been made in the past ten years in the design of steel mill a-c power distribution systems and equipment for these systems, there is still much to be done. Power systems are quite often far too complicated. A simple system with very highly reliable equipment well installed is always a more reliable, better, easier to operate system than one with a great number of complications and interconnections. It is a common fallacy that the more lines one can draw from one point to another in a power distribution system diagram, the better is that power system. Experience indicates that directly the opposite is true — the simpler that system can be made and the more reliable equipment that can be purchased and put in, the better is the over-all operation that will be obtained. It certainly is desirable in times of system failures to have simple systems so that the operators can understand and operate them effectively to restore service quickly. It is interesting to note that in designing one of the larger ordinance plants, simplicity was stressed as the number-one point in obtaining over-all system reliability. As equipments become more and more reliable and installation methods better and better, more dependence can be put upon the equipment for obtaining service reliability and in that way duplication of circuits and complicated interconnections can be eliminated to reduce the cost and improve the performance of steel mill power distribution systems.

Use the best equipment obtainable, install it in the best manner possible, and use simple systems and you will get more for your dollar in steel mill power distribution systems.

Figure 13 — Interlocked armor cable installed in metal cable racks supplying power to overhead plug-in bus duct in a metal products fabricating plant.

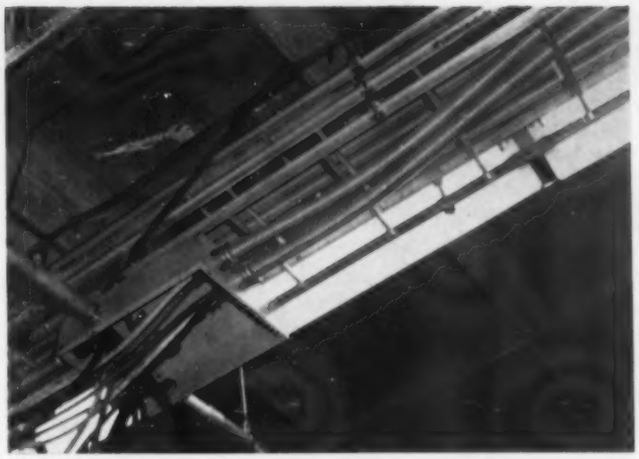


Figure 14 — Cable tap box sheath for interlocked armor cable from overhead metal cable rack.

DISCUSSION

PRESENTED BY

G. W. BAUMGARTEN, Electrical Engineer, United States Steel Co., Edgar Thomson Works, Braddock, Pa.

WILLIAM B. FERGUSON, Electrical Engineer, Freyn Engineering Div., Koppers Co., Chicago, Ill.

D. L. BEEMAN, Manager, Industrial Power Div., General Electric Co., Schenectady, N. Y.

G. W. Baumgarten: I would like to know the size of the plant which is mentioned as being applicable to

the higher voltage. From an ordinary steel mill engineer's viewpoint the author's argument applies only to the largest steel plants. For about 95 per cent of us, mill distribution loads of 50 to 100 thousand kva are not applicable.

The interlocked armor cable seems to me to be more expensive than is necessary. I prefer to use the neoprene jacketed cable which can be put in racks or installed outdoors or even buried in the ground, and the cost certainly would be less than for the interlocked armor cable.

William B. Ferguson: You people who have the responsibility of making layouts and estimates, etc., could help us, for the rapid determination of equipment prices is always a factor, and it is often not expedient to call some one.

Would it be possible to slip a page or two into your book on substation layouts giving prices of main items of equipment, such as breakers, transformers, etc? We would also like a set of prices on motors and controls; these prices could be so much per kw or kva for perhaps motor and control combined, or separate if that is better.

I have seen figures of $175 per horse power for main drives of a given size complete with control. Auxiliary motors and control may run $125 per horse power, etc. Such figures would help us immeasurably. It would, of course, be necessary for us to develop labor figures which is our job after all.

D. L. Beeman: In answer to Mr. Ferguson's questions, I have started out to do the very thing he is talking about several times during the past ten years. I think you all know what has happened to equipment prices and installation costs. To get a really good comparison of equipment and systems, one should make the comparison on an installed basis. I hope we will be able to make such curves available some day. They would not only be useful to Mr. Ferguson, but to ourselves as well.

Of course, there are some dangers in publishing such data in curve form. First, we can not describe all of the conditions of such curves clearly enough so they will always be clearly understood. They will always have to be interpreted in view of the local conditions.

Secondly, someone is liable to use such data for firm estimating or for making an appropriation request and find that he was in error by a considerable margin because the figures in the curves did not apply specifically to his conditions.

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STEEL MILL LUBRICATION—
Past, Present and Future

By N. I. WHITELEY
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American Steel & Wire Div.
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Cleveland, Ohio

. . . . "blessed is the lubrication engineer that putteth down friction and reduceth the heat thereof" . . . .

▲ WITH all the millions of dollars spent for steel mill machinery, it is only in recent years that much attention has been paid to lubrication. It was recognized of course, that lubrication was necessary in order to keep machinery running, but labor was cheap and so was oil and grease, particularly the black oil, red engine oil and cup grease in general use. Plain bearings with loose fits with open pockets on top where waste was inserted were the usual type used. Open gears were the rule, particularly on main drives. Speeds and loads were not high and neither was production. The oiler was one of the lowest or the lowest paid men at the mill. No training was necesary. Just give anyone an oil can and let him do his best. Screwdown cups were the means used for applying grease. Open gears were lubricated by heating an asphaltic petroleum product called gearshield grease and poured from an open bucket over the gear teeth.

As the number of lubrication points were increased, it became more and more difficult for oilers to cover all lubrication points in the mill. One of the first improvements made was the development of the grease fitting and grease gun. The pin type and dot type were the first types developed, then came the hydraulic and push type fittings and flush and button head type. The dot and pin type fittings are still used, but the type of gun used must be filled by paddle or by hand. The hydraulic, push type and flush type fittings can be filled from a gun fitted with a filler fitting thus avoiding messy handling and keeping the lubricant clean. Flush type fittings are used where clearance will not allow for the fitting projecting beyond the surface of the machine.

Usually the fittings had a ball check in the body of the fitting, but during World War II an improvement was made in the hydraulic fitting by locating the ball check in the top which helped to seal out dirt which could accumulate in the space between the top of the fitting and the ball check.

The first guns for servicing these fittings were of the screw type where the gun was filled by means of a paddle or by hand from an open bucket of grease. Mill dirt and scale and other contaminants could easily get in the grease and be fed to the bearing, where damage would result. This is particularly true since the widespread usage of ball and roller bearings. Since even a small amount of dirt can damage an antifriction bearing, it was necessary to develop guns that could be filled by other means than the open bucket and paddle method. To accomplish this a fitting was inserted in the barrel of the gun and a pump was developed to fit a 25 or 35-lb grease pail and having a fitting on the pump that would fit the gun filler fitting on the hand gun. Thus the gun could be filled by pumping the grease direct from the sealed container to the hand gun thence to the bearings.

Another way of accomplishing this is from a 100-lb drum with a hand pump and gun filler attachment for filling hand guns direct from the drum. This larger size container can be used in departments where consumption is comparatively small and distant to machinery from the central supply station is not great.

Another way is to use a 400-lb drum with a hand or air operated transfer pump to a 35-lb portable filler bucket and thence to the hand gun through a gun filler fitting. Where distances from the lubricant station are great and it is necessary to carry a quantity of grease to the machinery, this method saves retracing steps and time.

All of these improvements were a big help in the problem of better lubrication and are still being used, but with the multiplicity of grease fittings in the modern steel mill it would be impossible to lubricate all of the grease fittings in the mill without an army of oilers. Even then the job would not be done correctly as it is easy to skip a bearing particularly those that are not easily accessible. Some bearings can never be hand lubricated while the mill or machinery is operating because of the danger involved, yet these bearings need frequent lubrication to keep them operating. All the oiler can do is to overgrease or over-oil the bearing and

hope the lubricant will last until the next week-end shutdown. With this type of hit-and-miss lubrication it is obvious that poor lubrication will result in lost bearings with consequent maintenance expense and lost production. An attempt was made to overcome some of these difficulties by running long lead lines to all bearings of a machine from a header block containing grease fittings. At least the oiler could reach all bearings from a safer place. This was an improvement but the oiler had no way of knowing how much grease was needed for each bearing. Some way had to be developed to measure the lubricant.

With every pound of steel needed today and mills striving to break all production records, it is imperative that bearing failures and consequent shutdowns be cut to a minimum. About twenty years ago a system was developed whereby all bearings could be lubricated from one central pump and the lubricant, whether grease or oil, be measured in the proper quantity while the machinery was operating. The advantages of such a system can easily be seen. First it enables the oiler to reach a great many points of lubrication in his department and the number of oilers required is less.

Second, it is better to supply small quantities of lubricant frequently to a bearing than one large amount at infrequent intervals. Over-lubrication causes overheating of bearings due to frictional drag of the lubricant itself. Third, safety hazards of lubrication around danger zones are eliminated and inaccessible points can be reached.

Fourth, wastage of lubricant is stopped because the right amount of lubricant is supplied to the bearing at the right time.

Fifth, maintenance costs from bearing losses and production losses from shutdowns are minimized.

There are various systems on the market today using hand pumps of the 5-lb to 12-lb capacity and electric or air operated pumps.

The metering or feeder valves vary from the fully hydraulic type to the spring actuated piston type.

The hydraulic valve follows simple hydraulic principles. Lubricant is pumped from a reservoir through a 4-way valve to a piston. The piston is forced upward by the lubricant, a relief line carries lubricant back to the reservoir. By changing the 4-way valve position the flow is reversed. By substituting a modern lubrication valve the same principle is used.

On the spring type of valve, the spring returns the piston to its original position when the pressure is relieved.

A reversing valve is required on the hydraulic valve system while the spring supplants the reversing valve on the spring metering valve system.

TYPES OF PUMPS

Hand pumps of 5 to 12-lb capacity are used on small pieces of equipment, and as many as 60 bearings can be served by this pump if they are not located too far from the pump. Copper or steel tubing is usually used and if distances are over 50 feet, the line resistance would make the pump work too hard. Small motor driven pumps are also available for machinery, and where fully automatic lubrication is desired these pumps and motors are controlled by a time clock where a pre-determined lubrication cycle can be used. Manual push button control can also be used where less frequent lubrication is desired.

Another pump offered by one manufacturer can be driven by a cam attached to a drive shaft on the machine to be serviced.

Overhead cranes are an ideal application for this pump, and a hydraulic metering valve system with a reverser is used with this pump. The crane is thus lubricated only when it runs and it is only necessary to fill the pump to keep it operating. Usually once a week is sufficient if a 12-lb reservoir is used.

The pump has a spring loaded reservoir to keep a constant head on the pump and prevent air pockets. It is filled from the bottom with a grease pack.

Many other applications can be served by means of this pump and costly motors, reversers and electric controls eliminated. This makes an economical system.

TYPES OF SYSTEMS

There are a number of types of centralized systems on the market today and a brief description of each will be given.

Single line reversing systems with fully hydraulic metering valves—This system has a pump, either hand or motor driven. Lubricant leaves the pump and flows under pressure up to 35 psi through each metering valve and the bearings it serves and comes back to the pump where an indicator stem in the pump shows the lubricant has completed its cycle and all bearings have received their lubricant. A reversing valve at the pump, either manually or electrically operated, reverses the flow of lubricant around the circuit and the indicator stem on the pump again shows when the cycle is completed. Feeder blocks are of solid steel. If any feeder valve does not operate the indicator shows this. The whole system will not operate.

Dual line reversing system—This system has a pump either manually or electrically operated, but two main lines serve the hydraulic feeders in the system. Lubricant flows through one main line to each feeder and the end feeder is plugged. When a manual or automatic reverser works, the lubricant flows through the other main line in the reverse direction. Feeders may be teed into the main line on this type system. Each feeder has indicator stems which show when that bearing outlet has delivered its lubricant. This system operates at 1000 psi or less.

Single line, non-reversing, spring type metering valves—This system has the same pumps either air, hand or electrically operated, a single main line and metering valves or injectors which have a spring in the injector to return the injector piston to its original position after the lubricant has discharged and the pressure is relieved.

Single Line, non-reversing system M or MX type—No reverser is required for this system. Automatic, motor, cam operated pumps or hand pumps may be used with this system. Metering valves have small pistons that work back and forth and feed lubricant

as long as the pump is operated. Valves are gauged to the size of the bearing so that a film of lubricant 0.001 in. thick will cover the area of the bearing.

These systems can be made fully automatic by using timers on the pumps so the predetermined lubrication cycle can be set from 1 minute to 4 hours.

Like any other mechanical device these systems require regular inspection and maintenance. Cobbles, mill wrecks, vibration, and similar occurrences can break tubing or pipe lines and feeder blocks may become clogged. A maintenance and spare parts department is necessary in a large steel mill where a number of centralized systems are installed. In this stock room are kept all lubrication system parts not only for centralized systems but for all lubrication equipment.

Men must be especially trained for the work, and the supplier of the equipment will aid in training men to maintain this type of equipment and teach them how to install it.

On the subject of installing systems of this type, it cannot be too strongly emphasized that no system is any better than the way it is installed. Care must be taken that all pipe lines, tubing, hose and meter blocks are not in the way of operating or maintenance men. If it is it will be destroyed quickly. When installed correctly these systems sell themselves and the mill personnel will demand more installations.

When these systems were first installed it was the policy to run long lines and connect as many bearings to one pump as possible which meant that up to several hundred bearings had to be lubricated at the same time. It is much better to install a number of smaller systems because some bearings may not require the same frequency of lubrication as others, and while the amount of grease can be controlled by the size of metering valves to different size bearings, or different speeds, the only way you can control the time frequency is to separate these bearings from those requiring more frequent lubrication and put them on a separate system with another pump and different time cycle.

An illustration of this idea is used on the finishing train of a modern hot strip mill. Each stand has an individual automatic system. The lubrication cycle on the different systems can be changed according to load or speed changes by simply changing the electric timers. A similar mill fifteen years ago used two pumps for the six mill stands and the scale breaker.

A 4-stand tandem cold mill had a single pump installed 12 years ago to serve the centralized grease system on all four stands. Recently a similar mill was built and four separate systems were installed, each with separate pumps and time clock control. Pumps were located in the basement with timers and controls on the mill floor level.

BLAST FURNACES

Lubrication of blast furnaces has always been difficult because of gases on tops, sheaves in inaccessible places and consequent danger to the oiler.

Centralized systems are a distinct advantage on blast furnaces. Pumps can be located in safe places and all points lubricated from a power pump with time clock control, or hand pumps can be used for top lubrication and a number of systems used. Bull wheel, distributor, revolving top and seal ring are all covered as well as dangerous locations as sheaves outside the platform. Flue dust can bury the feeder valves and they still operate.

OVERHEAD CRANES

Both trolley and bridge can be lubricated with these systems, either hand operated pumps, one for the bridge and one for the trolley or cam operated pumps run from the bridge drive shaft and trolly drum shafts have proved a most effective means of lubricating overhead cranes and eliminating the danger of the craneman falling from the crane.

The systems just discussed are being used in steel mills throughout the world. The old type methods of hand oiling and greasing and hit-and-miss methods are disappearing. What of the future?

Machinery is being designed that could not be lubricated without systems of this type as all bearing are covered inside the machinery. This is the modern trend and many pieces of machinery are equipped by the manufacturer before shipment.

Probably the greatest changes and improvements in lubrication in the future will come not from these systems but rather in the lubricant used.

Extreme pressure lubricants are being improved for better load carrying ability and resistance to emulsion with water.

New chemical additives such as molybdenum disulphide have entered the lubrication field and some difficult lubrication problems have been solved by its use.

No doubt with the passage of time and as a result of the constant research of various oil companies, other chemicals and additives will be developed which will still further solve some of our lubricating problems.

Non-melting greases, unheard of a few years ago, have been developed and have been proven most successful in hot applications with which we in the steel industry constantly have to cope. These will not only be used in ever increasing quantities, but will no doubt be improved by the research chemist.

The old method of pouring gear grease from open buckets on open gears is disappearing. Instead, fluid cutback, extreme pressure gear lubricants are used and sprayed on the gears through spray nozzles. Some of these systems are automatically time clock controlled so a minimum of lubricant is wasted. Savings up to 90 per cent have been recorded on lubricant consumption and better housekeeping results as gear guards and the surrounding area is kept clean.

One thing is certain—wherever you have two surfaces rubbing against each other you have friction. The only way to minimize the wear that will develop is to provide lubrication.

We have seen the man with the oil can slowly disappearing and in his place the automatic systems, better lubricants and lubricating engineers to aid in the vital job of stopping friction. In back of him is the research man in the laboratory constantly working, developing, testing and experimenting to improve lubricants to keep down friction.

STANDARDIZATION IN THE LUBRICATION DEPARTMENT

By J. D. LYKINS
Chief Lubrication Engineer
Wheeling Steel Corp.
Wheeling, W. Va.

. . . . standardization of lubricants and equipment has reduced unit buying costs ten per cent, simplified training, reduced inventory and storage space . . . .

▲Standardization in the steel industry offers tremendous dividends to the steel mill operators. Standardization simplifies many operating problems and makes possible the more economical production of steel products. This trend towards standardization is evident in industry generally and in certain governmental functions such as in the Armed Forces.

The realization of its importance was brought out early during the last war when the demand of the armed forces procurement load placed upon the productive capacity of this country demonstrated the need of standardization. In 1943, a joint Army and Navy Board was established to meet this demand and develop what are know as the J.A.N. specifications. They had developed 565 specifications and 5 standards by 1948.

Also in 1943, Britain, Canada, and the United States held the first international conference on screw thread unification. Five years and five conferences later, in 1948, they agreed on a unified standard. The screw thread systems of the United States and the United Kingdom are now interchangeable. This fact is of tremendous importance to the security of the western world.

Industry has realized the importance of standardization for a great number of years. The railroads have standardized on track widths, hookups and switches so that today we can travel from one railroad system to another without any delay or confusion.

In the electrical field, standards for current and voltage have been established whereby electrical appliances can be shipped to any section of the country with never a thought but that they will meet with the same current and voltage wherever they are plugged in.

In the steel industry, standards have been established for pipe sizes, for gauges of sheet steel and the shipping and packaging of steel, and many others too numerous to mention.

This workable and interchangeability of parts and practices is standardization.

Standardization has been an important factor in easing and simplifying our way of life until today the people in the United States enjoy a higher standard of living than any other country in the world.

In 1939, the management of the Wheeling Steel Corporation saw fit to establish a lubrication department headed by a lubrication engineer located in the central office with a lubrication engineer in each of the various plants. One of the first duties of the new lubrication engineer was to make a complete and extensive lubrication survey of the equipment under his charge. Much to his surprise, after completion of the survey, was the wide variety of lubricants and lubrication equipment being used throughout the various plants and departments. The need for a standardization program soon became apparent. Standardization is a tedious process and something that can not be done overnight. One has to start at the department level in the plant and work up. The problems one will encounter in standardization even in one department are surprising.

In the cold strip department at one plant of the corporation, there are eight shearing lines, all similar. To lubricate the main gear drives, five different type lubricants were being used which are as follows:

1. A 1600 sec @ 100 F SUV straight mineral oil.
2. A 1900 sec @ 100 F SUV 5 per cent acidless tallow compounded cylinder oil.
3. A 1200 sec @ 100 F SUV lead napthenate type extreme pressure oil.
4. A 1500 sec @ 100 F SUV residual type oil.
5. A 300 sec @ 100 F SUV straight mineral oil.

To find a wider variety of products being used to

TABLE I

Type product	No. of brand names	No. of types	No. of viscosities and consistencies	No. of lubricants on inventory
Extreme pressure oils	8	4	6	33
Cylinder oils	15	5	7	44
Black oils	5	1	2	10
Straight mineral oils including turbine transformer oils, etc.	44	11	13	128
Motor oils	6	2	5	24
Diesel oils	2	2	2	2
Extreme pressure greases (lime base)	6	4	5	16
Lime base greases	13	1	5	47
Soda base greases	12	2	5	44
Mixed base greases (lime and soda)	3	1	4	6
Lime base greases (fillers)	4	4	6	12
Cold neck greases	2	2	2	2
Open gear lubricants	5	1	2	7
				375

lubricate similar equipment would be difficult. However, these were the products recommended by the equipment manufacturer when the equipment was installed. Inspection of the gears revealed that the 300 sec straight mineral oil was too light in viscosity. The gears were spalling and metal to metal contact was apparent. However, the gears lubricated with the higher viscosity oils were in good condition. Further inspection revealed that the operating temperature of the gears being lubricated with the 1900 sec @ 100 F compounded cylinder oil was 25 to 30 F higher than those lubricated with a 1200 sec @ 100 F extreme pressure lead napthenated type oil. In this case the decision was made to standardize on the 1200 sec at 100 F extreme pressure oil for this and all similar operations.

In 1940 there were over 375 different oils and greases including the various viscosities and consistencies being used throughout the Wheeling Steel Corporation. Table I gives a breakdown of those products:

Before the lubrication department was established, the mechanical foreman in the various departments of the plants were responsible for the selection of the lubricants. This resulted in the large number of similar type lubricants and often times the improper type of lubricant was used. The equipment builder also contributed his part, as was pointed out earlier, by his numerous recommendations.

Since the lubrication department started on a standardization program, the number of lubricants, including the various viscosities and consistencies, has been reduced to 130. However, the program is far from complete.

Listed in Table II are the breakdowns of the various products now in service:

In one plant where considerable progress has been made toward standardization, the number of lubricants being used has been reduced from 147 to 24. This includes the various viscosities and consistencies of the lubricants which are listed in Table III.

Standardization of lubricants is not the only concern of the lubrication engineer. He is also vitally concerned with lubrication equipment such as grease packs, grease guns, oil and grease cups, centralized grease and oil systems, valves, pumps and sprays, as he is either directly or indirectly responsible for maintenance of same. In one plant of the corporation, a group of ma-

TABLE II

Type product	No. of brand names	No. of types	No. of viscosities and consistencies	No. of lubrication on inventory
Extreme pressure oils	3	2	4	11
Cylinder oils	4	2	3	6
Black oils	2	1	2	4
Straight mineral oils including turbine and R. & O. oils	12	4	6	32
Motor oils	2	Similar	5	10
Diesel oils	3	3	3	9
Extreme pressure greases	4	2	4	10
Lime base (cup grease)	2	Similar	4	7
Lime base (filler)	2	2	3	6
Soda base	4	2	5	16
Cold neck grease	2	2	2	2
Open gear lubricant	2	1	2	4
Mixed base	1	1	3	3
Bentone	1	1	4	4
Lithium	2	1	2	4
Barium	1	1	1	1
Molybdenum	1	1	1	1
				130

TABLE III

Type product	No. of types	No. of viscosities and consistencies	No. of lubricants on inventory
Cold neck grease	1	1	1
Lime lead base extreme pressure grease—350 F M.P.	1	2	2
Lime lead base extreme pressure grease—190 F M.P.	1	2	2
Mixed base (calcium and soda)	1	2	2
Bentone grease	1	2	2
Lime base (graphite filler)	1	1	1
Red engine oils	1	2	2
Cylinder oil	1	1	1
Lead napthenate type extreme pressure oil	1	3	3
Turbine type oil (R. & O.)	1	2	2
Turbine type oil non-inhibited	1	1	1
Diesel 2104-B oil	1	3	3
Solvent cut back type gear shield	1	2	2
			24

chines made by the same equipment builder were being lubricated by means of oil cups. The bearings were all of the sleeve and approximately the same size, but the equipment builder supplied these machines with three different types and sizes of oil cups.

The capacity of the smallest cups was such that they had to be filled every four hours. Therefore, the frequency for filling and checking all of the cups was set at four hours even though the largest cup had a capacity for over twelve hours. There being ample room for the installation of the largest size cup on all of the machines, the decision was made to standardize on the largest. The frequency for filling and checking the cups was then extended to eight hours with ample supply of oil left in the cups for safety. This left time for the oilers to be assigned other lubrication duties.

In each of the plants throughout the corporation, lubrication repair shops have been set up. Here all of the major repairs and most of the minor repairs on lubrication equipment are made. If a grease gun should be broken in the field, the gun is returned to the shop where repairs will be made or the gun will be exchanged for a new one. Prior to standardizing on one type of grease gun, the problem of maintaining a stock of spare parts in inventory to supply the needs was difficult. In some plants, grease guns have been thrown in the scrap pile for the sake of an eleven-cent washer. This same condition existed in the Wheeling Steel Corporation. If spare parts were not in stock, the guns were thrown in the scrap. Since the decision was made to standardize on one type of grease gun, a minimum number of spare parts are carried in inventory, and the problem has been considerably relieved.

Wherever possible, pumps of the same type and size have been standardized. This permits a minimum number of spare parts and pumps to be carried in stock. If one should become inoperative in the field, it is replaced with one from stock, and the other is returned to the shop for repair. This procedure has reduced the time of delay on various operating units to a minimum. This same procedure is carried out with distributing valves, pressure control valves, and all other lubrication equipment.

A number of points have been covered as to what Wheeling Steel has done towards standardization, but our greatest problem was that of determining the type and kind of lubrication equipment on which to standardize—the one that would give us the best possible operating condition at the most economical cost. The quality of a lubricant can not be determined by its cost as there have been numerous instances where the cheaper product has proved to be the better lubricant. Laboratory tests will not always tell us what a lubricant will do in actual operating service because of the many variable operating conditions. They only serve as a guide in predicting their operation. The performance prediction of a lubricant recommended by a lubrication sales engineer can not always be depended upon. There have been a number of their recommendations that have been complete failures in the field.

This presents a problem to the lubrication engineer as the field test of any lubricant or piece of equipment is the final answer of the product's true value. To field test all lubricant would be physically impossible. Therefore, a method for screening the various products to determine which has possibilities for field testing without endangering the operations of a major piece of equipment is the responsibility of the lubrication engineer.

To overcome this problem, the Wheeling Steel Corporation has set up certain chemical and physical specifications which the lubricants must pass before they are approved for field testing. To illustrate, a turbine oil must meet and pass the following specifications and tests:

Gravity API minimum	— 29
Color ASTM	— 1½
Flash temperature F minimum	—385
Fire temperature F minimum	—435
Viscosity SUV @ 100 F	—145/170
Viscosity SUV @ 21 F	— 42/46
S.E. No.	—Dependent on type inhibitor

Must pass the ASTM D665-49T rust test.

If the oil passes these specifications and tests, it will be approved for testing in one of the turbines. At specified intervals, oil samples will be taken and tests will be made of same for neutralization, S.E., and interfacil tension numbers. Also, sludge accumulation and rust tests will be made. If the oil passes the require-

ments of these tests and inspection of the turbine shows that the protection expected from the oil has been obtained, it will be placed upon the approved list.

Extreme pressure type oils must meet the following specifications and tests:

No. 2 Extreme Pressure Oil

Flash temperature F minimum	—350
Fire temperature minimum	—400
Pour temperature maximum	—+10
Viscosity @ 100 F SUV	—725/775
Viscosity @ 210 F SUV	— 65/75
Type additive	—Lead napthanate
Timken test	— 35-lb minimum
Must pass ASTM D665-49T rust test	—Copper strip test
Non-corrosive	@ 200 F for three hours

If the oil meets these requirements, field tests will be conducted where a close check on the viscosity, Timken value, water separating ability, and corrosive effect will be made. Also, inspections will be made of the gears and bearings to determine the effectiveness of the oil in preventing excessive wear. If the lubricant passes these specifications and tests, the lubricant will be placed on the approved list. Then the lubrication department, in conjunction with the purchasing department, determines the product to be purchased. There are usually a number of similar type products which are on the approved list. This permits the purchasing of a product offered at the better price.

In developing the standardization program, the oil industry and the equipment manufacturers have cooperated with us wholeheartedly in furnishing pertinent data concerning their lubricants and equipment.

The Wheeling Steel Corporation has realized a number of advantages through the program of standardization which are as follows:

1. Permits buying in larger quantities—permitting savings in unit costs. In numerous instances the savings are as much as 10 per cent.
2. Simplifies training programs—by having a minimum number of different types of equipment, the problem of training maintenance personnel is eased and by having a minimum number of lubricants, the lubrication training program is simplified.
3. Reduces the amount of required storage space. In the Wheeling Steel Corporation, a thirty-day supply of all lubricants plus an added amount of oil equal to the largest capacity oil system is maintained in inventory. So, if for any reason, the oil should have to be changed or should be lost through some unforeseen mishap, there will be sufficient oil to prevent any undue delay in production. Therefore, should there be five 1,000-gal oil systems all supplied with five different type oils, it would be necessary to carry 5,000 gal of oil plus a thirty-day supply in inventory. However, if they were all supplied with the same type oil, only 1,000 gal plus a thirty-day supply would have to be carried on inventory. This would reduce the storage space required 80 per cent. The same is true with equipment. With a minimum number of equipment types being used, a lesser number of spare parts are required in inventory.
4. Permits faster turnover of lubricants and equipment reducing the possibility of deterioration in storage.
5. Eases the problems of purchasing and inventorying by having a minimum number of products to purchase and inventory.
6. Permits buying to controlled specifications. This simplifies the problem of lubrication and permits better control of lubricant application.

The savings to be gained by standardization would be hard to evaluate. Nevertheless, it has reduced costs and increased production by reducing the down time of operating units.

DISCUSSION

PRESENTED BY

FRANK L. GRAY, Lubrication Engineer, United States Steel Co., Gary Works, Gary, Ind.

GEORGE SPEHN, Special Lubrication Engineer, Standard Oil Co., Chicago, Ill.

J. D. LYKINS, Chief Lubrication Engineer, Wheeling Steel Corp., Wheeling, W. Va.

CHARLES TAYLOR, Sun Oil Co., Pittsburgh, Pa.

T. L. COREY, Research Engineer, Lubricants Div., Aluminum Research Labs., Aluminum Co. of America, New Kensington, Pa.

Frank L. Gray: I agree with the statement of Mr. Lykins on the worth of standardization and his definition of the term as outlined in his paper, and also his comments on the standardization of lubrication equipment. However, the balance of his dissertation should more aptly be termed lubrication engineering. In this he has done a worthwhile job.

Thirty years ago we had standardization within our plant. One oil and grease supplier furnished about ten or twelve types and grades of oil and two greases. His residuum from the stills cut back with a light distillate was starting to replace our coke plant tar as a gear protection. Another supplier furnished four greases and our graphite grease for hydraulic pumps was a specialty item. Today we have many more suppliers and many more types and grades of oil and grease.

Any program of standardization must include exceptions to the rule. It is true that some products may overlap in the application of a common operation. Laboratory and field may not agree on results. Engineering and operation may not be in accord on selection of product. We therefore, must include a factor in our formula, whereby X will equal the human element.

Where X=100 per cent, the true worth of a product can be found. Any lesser value for X will be in direct proportion to the final results.

The steel mill operator is responsible for the productive output of his unit. Preventive maintenance, including lubrication is also his responsibility. He must have sound, intelligent advice on matters of lubrication. We cannot relieve him of these responsibilities by a program of standardization. We can continue to em-

phasize the efficiency of a well planned program where X in the formula will equal 100 per cent.

George G. Spehn: I would like to ask the author how you can write specifications on turbine oil and still not require an oxidation test on it?

J. D. Lykins: The new oil is required to pass an accelerated oxidation test which I failed to list in the new oil specifications. Also, oxidation tests are run periodically after the oil is in service, along with sludge accumulation, interfacial tension, neutralization and rust tests.

Charles Taylor: After the oil has been in service, when would you take that oxidation test?

J. D. Lykins: Oxidation tests are run on new oils being field tested at three-month intervals. After the oil is approved, they are run every six to eight months. I might add that at one plant of the corporation, there are two turbo-blowers operating under very severe conditions. The air intakes are directly facing the blast furnaces. As a result, iron ore and other solid contaminants are drawn into the turbo-blowers. A portion of these contaminants works its way past the oil seals into the oil system, along with water, which, if not removed, will eventually cause a breakdown in the oil and subsequent bearing failure. To overcome this condition, the turbines have been equipped with water legs to remove the water, exhauster fans have been mounted on the oil reservoirs to prevent condensate from forming, and cellulose type filters are used to remove solid contamination. This combination has worked out very successfully, and the oil is in excellent condition after five years service.

Charles Taylor: What is the yearly make-up?

J. D. Lykins: The yearly make-up is approximately 250 gal per turbine. The reservoir capacity is approximately 450 gal.

Member: How many men do you have in your organization to carry out the standardization program?

J. D. Lykins: There are ten members of the lubrication committee: five lubrication engineers, three maintenance superintendents, a representative of the purchasing department, and a petroleum chemist.

T. L. Corry: We have been engaged in a similar type of project in standardization since 1945 and, even at this date, we consider the project by no means complete. However, we have been successful within a span of about six years in reducing our lubricants inventory classifications by 80 per cent, each classification containing several interchangeable products to permit our purchasing departments as wide latitude as possible. We hope to further substantially reduce the present classifications.

A reduction from 375 to 130 lubricating products through standardization as achieved by Mr. Lykins represents a lot of hard work and considerable selling on his part to those who are charged with the responsibility of maintaining production equipment. We feel quite sure that he does not consider his job complete.

We note that of the 130 lubricants currently in use, 58 of these are represented by various types of greases. At first glance, it would appear that any given company such as a steel company might get along satisfactorily with a much lesser number. The greases might present a fertile field for further consolidation.

As regards the turbine oil specification described in Mr. Lykins' paper, we note the absence of an oxidation test as a measure of oil quality. This test seems to us to be one of the most important, if not the most important means of qualifying a turbine oil. Field tests, with subsequent measure of neutralization number and interfacial tension number are useful tests for turbine oils once they are in operation, but if the purpose is to seek out superior oils, considerable time could be used up in such a search if confined to field testing alone. Accelerated oxidation tests in the laboratory serve as aids in determining the suitability of a turbine oil, and when properly integrated with field testing, permit screening in a much shorter time.

The discussion regarding the use of lead naphthenate gear oils as a standard type of gear oil in the steel industry prompts the question: What are the advantages of the lead naphthenate gear oils over the sulphur-chlorine type? We are wondering whether the latter type of gear oil has ever been considered and, if so, what are its shortcomings as it applies to the steel industry?

We are in wholehearted agreement with the advantages of standardization as outlined at the end of the paper. It has been our experience that these are real and not theoretical advantages.

J. D. Lykins: In answer to Mr. Corey's question on sulphur-chlorine type oils, we have tested a number of the chlorine type oils and found that in the presence of water they have lost their extreme pressure properties much faster than those of the lead-naphthenate type.

WANTED !

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ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BUILDING, PITTSBURGH 22, PA.

RECONDITIONING AIR FILTER OILS

By GEORGE FINDLAY
Lubrication Engineer
Republic Steel Corp.
Buffalo, N. Y.

. . . . air filter has operated under severe conditions for 3½ years without loss of operating time for repairs and cleaning . . . . credit for this is given the oil reconditioning system . . . .

▲ THE steel industry, until recently, has attempted only to a limited extent to filter air used in its operation. The only general use of filtered air throughout the industry was confined more or less to cooling large critical motors, motor-generator sets and motor rooms. However, due to the ever increasing demand for steel and iron products facing the industry in recent years, it has been found necessary to provide preventive maintenance methods wherever possible to hold operating delays of prime movers such as blast furnace turboblowers, etc., to an absolute minimum.

In general, the costs associated with removal of an impeller for reconditioning and also the purchase price of a new impeller are relatively high. Unless excess blower capacity is available, the downtime occasioned by the necessary repairs is also found to be very costly, in direct relation to the loss of the blowing capacity.

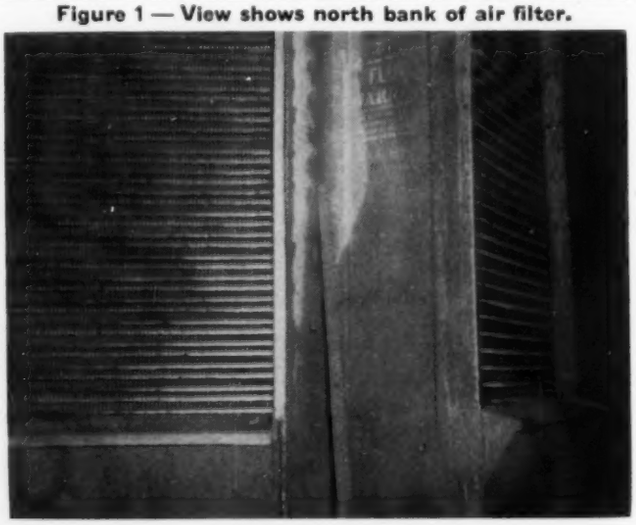
If, by instituting preventive maintenance measures, an increase in the service life of an impeller of a turboblower can be realized, the savings involved would quickly offset the initial investment in oil reconditioning equipment. Our experience has indicated that such savings are made possible by the installation of an oil reconditioning unit which will be described later in more detail. Our findings have indicated that these periodic impeller replacements are necessitated at least in part by the sand blasting effect of abrasive solids suspended in the intake air stream striking the leading edges of the blading and the rivets of the rotor at high velocity. Several different types of air filters are employed in the steel industry with those of the travelling screen design predominating where blast furnace blowing equipment is involved. For this type of operation we are primarily interested in removing only those solids which will abrade the impeller.

Experience has indicated that, to be effective, the air filtering system must be maintained on a continuous operating cycle. This in turn demands the installation of an automatic auxiliary oil reconditioning system to maintain the oil in the air filter screen reservoirs within acceptable limits of clarity.

Air filters as supplied by the manufacturer are in sections or panels. Each section has a reservoir of about fifty gallons capacity. Because of their construction, cleaning these screens in the field would be difficult and removing them for acid and steam cleaning would be extremely costly.

Irrespective of the type of fluid used in the air filter screen reservoirs, it is found that it becomes contaminated with large amounts of solids, water and their end products, such as sludges and acids, during normal operation. Unless these contaminants are continuously removed they will accumulate in the air filter screen

Figure 1 — View shows north bank of air filter.



reservoirs to a point where the screen proper will become plugged rather than cleaned during its passage through the oil bath. During periods of cold weather, the oil tends to become more viscous and builds up on the air filter screen. This condition is aggravated, whenever the contaminants are not removed from the oil continuously, to a point where it presents a hazard of carry-over of oil into the air stream on the discharge side of the air filter with its attendant fire hazard.

The air filter being discussed is installed in two banks of four sections each. In order to attain the desired continuous oil reconditioning, it was found necessary to modify the original design of the air filter reservoirs in the following manner. The reservoirs in the two banks are connected across the bottoms with 4-in. drain lines, with the last reservoirs emptying into a common return line. This in effect offers several of the advantages common to a large reservoir. The flow of oil is thus directed in a manner which will carry the solids away from the screen reservoirs to a point where they can be more readily removed without interfering with the screen operation. However, to maintain the desired operating level in the reservoirs, the oil leaving the last reservoirs is restricted by a valve to about 90 per cent of the pump delivery volume. The remaining 10 per cent is carried off by overflow lines installed near the top of the reservoirs. The overflow lines discharge through sight glasses installed at floor level into the receiving

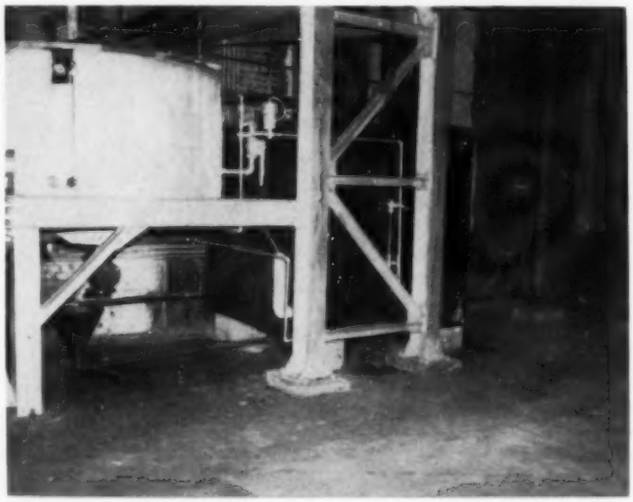


Figure 2 — Shown here are the receiving tank and gravity type filter with overflow, return lines, controls and gages.

tank. The operator is thus able to observe at all times the rate of flow through the overflow lines.

The oil which is carried by the common return line is also discharged into the receiving tank where it is heated and then passes on into a gravity type filter compartment. After flowing over the settling trays, the oil is maintained at between 130 F and 140 F in the clean oil compartment of the gravity filter by means of steam coils controlled by an automatic temperature regulator.

Two rotary type pumps of approximately seven and one-half gpm capacity transfer the partly filtered oil from the clean oil compartment of the gravity type filter and force it through two auxiliary activated earth

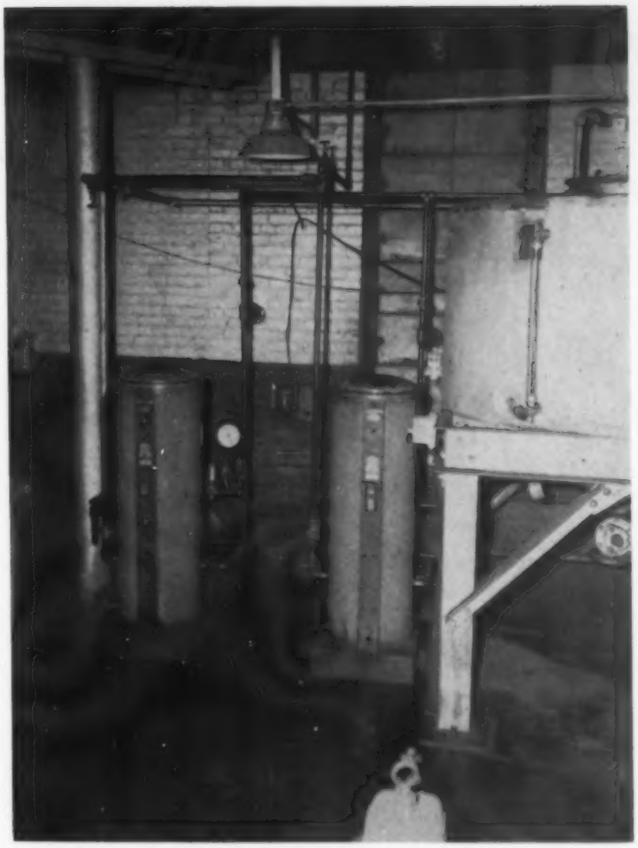


Figure 3 — Pumps, earth type filters and piping arrangement.

type filters of ten gpm capacity up to the air filter reservoirs to complete the cycle. The pumps are installed so that they may discharge to either bank of air filter reservoirs or into the receiving tank if desired.

The activated earth cartridges have shown average service life expectancy of about six weeks, and when removed, the twelve cartridges usually held about 180 pounds of solids. During a four-month test run, the cartridges were changed three times and at the end of the run the system was cleaned out. About 400 pounds of solids were removed at this time, which added to the material removed at the regular cartridge change periods, totaled approximately a half ton of highly abrasive

Figure 4 — Flow diagram of oil reconditioning unit.

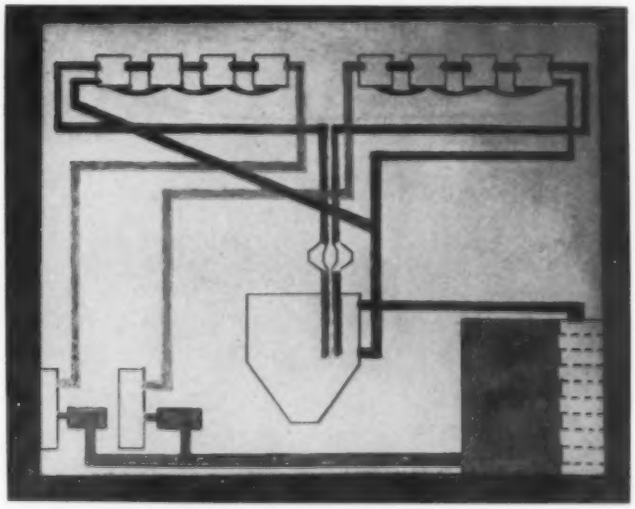


Figure 5 — Closeup of cartridges showing ⅜-in. buildup of solids after four weeks service.

solids removed from the air during the test period. Personal investigation has shown that the total solids load will vary with operating conditions and geographical locations.

The design of this reconditioning system permits us to remove the dirt load at ground level with a minimum of labor and disposal problems. Previous practice of handling solids and contaminated oils, demanded that they be removed manually from the screen reservoirs, generally located at some elevated point. Working conditions at this elevated point were found to be very unfavorable and extremely time consuming.

A recent installation of an oil reconditioning system of similar design to the one just described has incorporated several important improvements, based on the

Figure 6 — Solids removed from system after four months test run. A 6-ft rule is shown for comparison.

field experiences obtained with the former. In this case, the settling tank was enlarged to permit an operating system of approximately 7000-gal capacity which thereby offered additional settling time between cycles. In addition, the increased settling time provided by the larger tank capacity was found to reduce the build up of solids on the cartridges of the activated earth type filter which in turn extended the cartridge life expectancy. The air filter reservoirs are in this case, constructed with hopper type bottoms connected to a common return line by 3-in. pipe connections. The oil flow through the return lines is controlled by two flood gate type valves. The overflow lines from the top of the air filter screen reservoirs are connected to the common return line on the downstream side of the control valves as an added safety measure. Connections are provided with manually operated controls to permit flushing these hoppers and lines with air under pressure if desired. This feature was provided as a means of assisting in the removal of any build up of solids in the return lines. Experience to date has indicated it was unnecessary to use the air for the original purpose intended. Flushing of the return lines daily by manually opening and closing the control valves has proven satisfactory

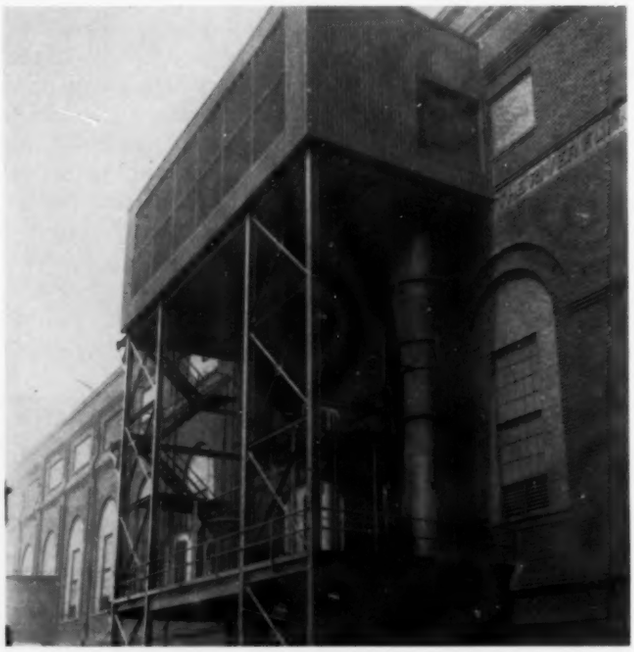
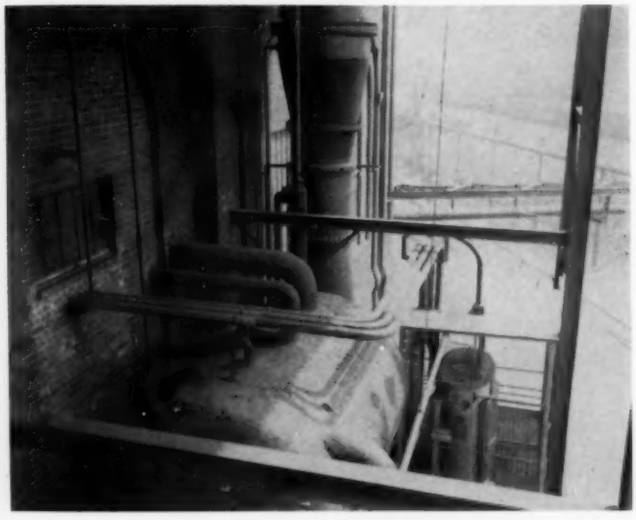


Figure 7 — Air intake for main power station.

in keeping the lines clear of solids. In addition, electric soil heating cables, thermostatically controlled, were installed in the air filter oil reservoirs and through the connecting drain lines, as a means of preventing the

Figure 8 — Return oil line has flash heater.



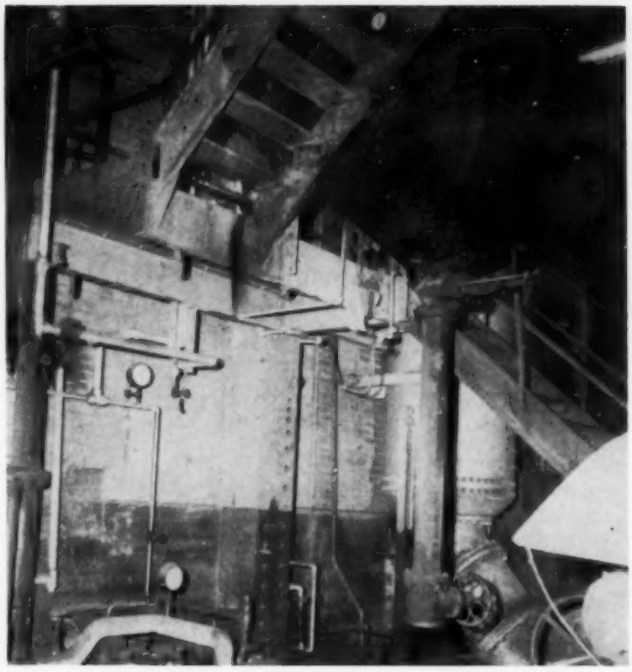
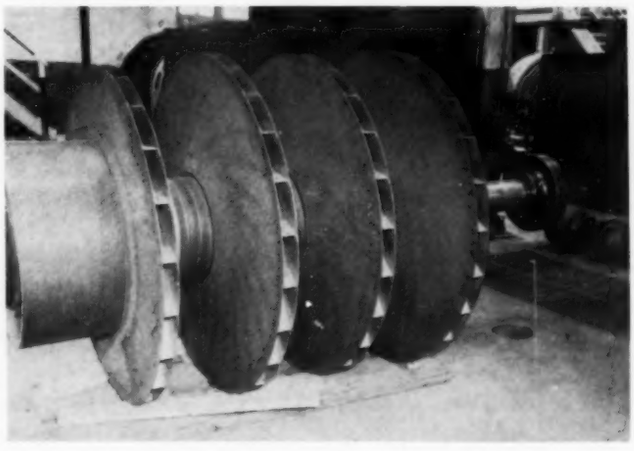


Figure 9 — Receiving tank is shown at top right.

Figure 10 — Closeup of air filter screen.

Figure 11 — Air impeller is shown after three year's operation.



formation of ice and sticking of screens during periods of cold weather. Metal baffles assisted in blocking the entry of snow and ice on the screen proper of this particular installation.

A large percentage of the pipe work in both the systems described would be unnecessary if air filters were available with all sections standardized to fit a common reservoir. However, only standard models are available to the steel industry at present. It is the writer's opinion that the increased cost of field fabrication and installation of large common reservoirs to meet the requirements of each individual installation would be fully justified by the savings in pipe work and by the increased efficiency of the oil reconditioning unit.

Installation of improperly engineered air filtering equipment is by no means confined to blast furnace blowing equipment only. The writer has observed an air filter supposedly protecting a large motor in a new motor room where the filter screens were so badly plugged with solids that the doors in each end of the housing were left open to allow a sufficient volume of air to reach the motor.

In a chemical plant recently visited, a one-section air filter was found to be out of service for cleaning purposes. Subsequent recheck with plant personnel involved indicated that a total of one hundred eighty-six manhours were charged to remove, clean and reinstall the screen. The cost involved in this operation might well justify the consideration of installing a similar oil reconditioning system to that previously described.

In closing, it should be noted that the air filter installed in the plant with which the writer is associated, has operated in a location where the conditions are

Figure 12 — Closeup of air impeller shows wear on rivets.

severe for three and a half years without any loss of operating time for repairs or for cleaning purposes, and without any oil carry-over into the cold air main. It is the writer's opinion that the oil reconditioning system deserves credit for this excellent performance.

This system is now scheduled to be cleaned out at six month intervals and the cartridges changed when necessary. During the twelve months just past, the cartridges were changed twelve times. Three hundred fifty gallons of oil were added during the year. Most of this amount was make-up when the cartridges were changed and when the system was cleaned out.

The labor charges are small. Two men change the cartridges in from three to four hours and clean out the entire system in approximately eight hours.

The oil in use is a low V.I. naphthenic base pale oil of 100 SSU viscosity, 330 F flash and a −25 F pour point, and has not been changed since the system was put into operation. A sample of the oil from the return line is analyzed every three months and we have maintained a neutralization number of less than one up to the present time.

After investigation by our General Safety Department of the non-flammable fluids which are sometimes recommended for this service by air filter manufacturers, it was deemed advisable, with the proper type of automatic fire extinguishing equipment installed, to accept the possible fire hazard associated with the use of mineral oils in preference to the toxicity hazards involved with the use of the former.

DISCUSSION

PRESENTED BY

J. D. LYKINS, Chief Lubrication Engineer, Wheeling Steel Corp., Wheeling, W. Va.

GEORGE FINDLAY, Lubrication Engineer, Republic Steel Corp., Buffalo, N. Y.

ANDREW CICHELLI, Lubrication Engineer, Construction & Engineering Depts., Bethlehem Steel Co., Sparrows Point, Baltimore, Md.

F. E. BLANCO, Lubrication Engineer, Republic Steel Corp., Youngstown, Ohio.

J. D. Lykins: Is air used for blowing the excess oil from the oil filter before cleaning?

George Findlay: We do not use air to blow out the oil filter.

Andrew Cichelli: Have you tried different type oils to see if there was any difference in performance?

I would like to tell you something that happened to us which might be of some interest. In one of our blower houses, we have a filter made up of oil-coated square panels filled with steel wool as the filtering medium. We had an enormous amount of trouble at first because not only were rivet heads cut, but even the rivets. We found, moreover, that experimenting with different oils made no difference. A test program was set up whereby a ping-pong ball was coated with vaseline and suspended behind the filters. As soon as dirt clung to the ball we knew the filter had become ineffective. By use of this method we discovered that three or four different oils having a wide price range were about equal in performance. To get out of trouble, we made only one change, relocating our air intake. In this particular case the air filters were on ground level and the air before entering the filter was dragging or sucking in dirt from the ground. All we did to solve our problem was to block off the lower intake and raise it about twenty-five feet in the air. After that, the ping-pong balls hardly ever became dirty again except after very long intervals.

George Findlay: We have not experimented with different oils in the air filters at the Buffalo plant. However, your question reminds me of a point I missed. Before our air filters were installed I cooperated with the lubrication engineer at another plant in running a test of several oils in an air filter there.

The air filter had six sections and each section was operated with a different oil in the bath. The oils ranged in viscosity from a light medicinal white oil to a heavy duty motor oil of 600 SSU. The test was continued for a month. We could see no appreciable difference in air filtering efficiency with any of these oils. We did think that we had a little more carry-over with the heavier viscosity oils.

Early in our operation we blended a detergent type cleaning fluid in the oil in our installation. This additive did not improve the efficiency of the air filters, but it did decrease the service life of the cartridges in the oil filter. The cartridges became coated with a thin film of this material which increased the operating pressure through the oil filter to the extent the cartridges had to be changed sometimes within twenty-four hours after being installed.

We have used only 100 SSU naphthenic oil since.

F. E. Blanco: In one experience we had with this type of system last winter, and it was a pretty severe winter, we did not have heaters in our screens and they froze up on us and sucked the oil right out of the bins with some getting to the turbo. In order to get away from a reoccurence we decided to heat the oil up to 180 F and increase the time cycle of the screens. They were originally set to move 12 seconds out of every 12 minutes or about an inch and a half every 12 minutes. We increased the time cycle to about 15 to 20 per cent of the time, that is, they moved about 10 inches every 12 minutes. We noticed during the remaining 3 months of the winter that we did not have any trouble from freezing screens.

It was a new experience with a new installation and that was the way we handled that problem.

J. D. Lykins: The Wheeling Steel Corp. has been experimenting with various types of oil filters to be used in conjunction with air filters for approximately eight years. The filter arrangement is similar to that described by Mr. Findlay. Our experience has shown that very good results can be obtained by the use of either cellulose or absorbent earth type filters. By the use of oil filters, the time cycle for the cleaning of air filters has been extended from three months to one year. This has reduced maintenance costs approximately 75 per cent.

APPLICATION OF BENTONE LUBRICANTS

By D. H. COMPONDU
Product Engineer
The Warren Refining & Chemical Co.
Cleveland, Ohio

. . . . the lubricant described is unusually stable over a wide range of uses . . . .

▲ THE steel industry is, or at least is a part of, the backbone of the nation, and any way that steel production can be improved is a benefit to all. We in the lubrication field feel that in the bentone lubricants, we have a contribution that will benefit the steel industry immensely. Before we can discuss the application of the bentone greases, it is first necessary to briefly explain the bentone lubricants themselves.

Bentone lubricants cannot truly be called greases in that the oils are not thickened by a soap, but are gelled by a chemical compound obtained by reacting a purified bentonite and an organic base. The fact that bentone, as it is used in lubricants, is no longer just a bentonite clay cannot be stressed too highly. The bentone used in the manufacture of bentone lubricants is as unlike bentonite clay, in its characteristics, as rust, which is an oxide of iron, is from iron and steel. This processing of the bentonite has been described in detail by Dr. J. W. Jordan in various papers, that have appeared in successive issues of the Journal of Physical and Colloid Chemistry. Bentone is the trade name of this re-acted vermiculite which bears little or no resemblance to its parent.

To give briefly a description of a bentone, it must be told as follows: Bentones are the reaction products of bentonite, or, more accurately, montmorillonite, and various organic cations. Montmorillonite is a Wyoming type hydrous magnesium aluminum silicate, with a micaceous structure, an exceptionally small ultimate particle size, with the cation predominantly sodium and occurring customarily as the salt of the moderately strong acid.

When montmorillonite is dispersed in water, the platelet particles separate to the ultimate, and each platelet orients water molecules about it in hexagonal configuration. This action gives use to the thixotropic gels of montmorillonite in water which make it valuable in oil well drilling muds and other applications.

To prepare a bentone then, the montmorillonite is hydrated in a very dilute dispersion to separate the unit particles, and is purified by super centrifugation to achieve complete removal of non-clay impurities.

This step is resorted to since most montmorillonites in the crude state contain relatively large quantities of quartz which, if allowed to remain, would impart an abrasive character to the resulting product. The reactive sodium atoms of the unit plates are then replaced by organic cations and the product washed, filtered, dried, etc., to give the final bentone. A suitable cation is ammonium.

In preparing a bentone, the use of a quaternary ammonium salt with two long chains of 16 to 18 carbon atoms each gives a completely hydrophobic and organiphilic bentone and greatly improves the heat stability. This product then has no affinity for water, but because of the hydro-carbon chains coating the platelets, disperses readily in organic liquids to their ultimate, and binds the organic liquid in oriented layers. The result is then a gel system in which the organic liquid phase is held immobile as a hull around a hydro-carbon coated platelet. The resulting gel is, in our application, a completely finished lubricant having been achieved by physical rather than chemical means.

In application, the bentone lubricants have shown themselves to be exceptionally stable with a wide range of uses. By selection of the proper grades, it is possible to lubricate a complete plant with one basic product.

Great savings both in lubrication and maintenance costs have been affected in some plants now using the Bentone lubricants. To cite a few instances in which to prove out these remarkable savings, we have seen the bentone lubricants in service on one of the fastest pipe mills in the world. Runout bearings on this application were being replaced at from two to three week intervals when this manufacturer was using a soap type grease. Since then, changeover bearing loss has been cut to a minimum, in fact only one bearing has been replaced since January of this year. You are all familiar with the heat encountered here.

In this same mill, bentone lubricants have affected the same sort of savings on the charging cranes. Ingot buggies, in spite of the changing temperatures encountered have shown that the bentone lubricants can effect savings in replacement parts. In one application that

has been reviewed, the operator was losing shafts due to improperly placed molds and other causes. This, of course, placed the lubricant under severe strain.

The intense heat resulting from the spilled material would cause the old lubricant to liquefy, allowing the oils to run out, upon cooling the soap mass would remain, offering little or no lubrication. After the change to the bentone lubricant, this condition was eliminated, due largely to the fact that the bentone product will not separate, as a result the number of broken buggy shafts was cut down considerably. At present the bentone lubricant is applied every fifteen days whereas formerly it was necessary to lubricate the wheels daily.

Another instance is the use of the bentones on sintering conveyors. As is known, reclamation of a great deal of ore, formerly wasted, is possible by this process. Several sintering plants throughout the country are now being lubricated with bentone lubricants. Probably no other applications can demonstrate as well the versatility of this product. One grade is normally used throughout, encountering high speed, low speed, dust, abrasives, heat and cold. Through all these varying conditions, the one lubricant that has performed successfully is of bentone origin.

Most steel mills depend on central lubrication systems to assure lubrication to their various pieces of equipment, again the bentone lubricants have shown themselves to be superior in this usage.

Even a number three penetration can be successfully pumped, showing no signs of separation in the process. This results in less blocking at elbows and outlets, as is common with the soap type greases. Containers need not be placed to accommodate the lubricant, but can be situated any place desired. Thus, if the pumping apparatus is outside or inside you will be assured of pumpability through all phases of weather conditions.

We have dealt so far with steel mills, but the use of the bentone lubricants is not limited to just these high heat applications. Bentone lubricants have been used in the iron mines enabling both pit and deep hole mine operators to realize a saving in lubrication costs. Coal mine operators, directly connected with the iron and steel industry, have proven the worth of these lubricants in their operations. Draglines, shovels and other heavy machinery furnish an active proving ground, subjecting the lubricant to heavy pressures, dirts, etc., as well as water conditions.

It might be well to mention at this point that while these lubricants will absorb up to one hundred-twenty-five per cent of their own weight in water, they will hold this moisture in perfect suspension. The water globules thus formed will have no effect on the consistency, the lubricity or adhesiveness of the product.

It is possible to cite all the various applications that these lubricants have been subjected to, however, this would be merely repetitious. We can thus sum up the qualities of the lubricants as follows:

1. The bentone lubricants, properly manufactured, have absolutely no melting or dropping point. They will not run, liquefy or lose adhesion even up to the oxidation point of the oils used in their manufacture. This characteristic assures adequate lubrication far beyond the point at which most other lubricants fail.
2. Unlike most lubricants, they contain no metallic soaps or fatty acids. Thus there is no problem of instability due to excessive amounts of metallic hydroxides or fatty acids, and little possibility of phase change.
3. Bentone lubricants, as before mentioned, are water resistant and are insoluble in the face of extreme water conditions.
4. They have greater adhesive properties than any other type lubricants because of their greater affinity for metals.
5. Their shear structure is such that less frictional drag is found than in any other conventional lubricant. This results in greater lubricity and better pumpability at all temperatures in all types of equipment.
6. These lubricants never lose their extraordinary adhesive and lubricity characteristics. They will provide superior lubrication for longer periods of time and for a greater variety of applications, so that their cost in use is much lower than any other lubricant.

DISCUSSION

PRESENTED BY

J. D. LYKINS, Chief Lubrication Engineer, Wheeling Steel Corp., Wheeling, W. Va.

D. H. COMPONDU, Product Engineer, The Warren Refining & Chemical Co., Cleveland, Ohio.

MAURICE RESWICK, Engineer, Standard Oil Development Co., Linden, N. J.

GEORGE FINDLAY, Lubrication Engineer, Republic Steel Corp., Buffalo, N. Y.

T. L. COREY, Research Engineer, Lubricants Div., Aluminum Research Labs., Aluminum Co. of America, New Kensington, Pa.

JOHN P. CRITCHLOW, Chief Engineer Lubrication & Fuels, Gulf Oil Corp., Gulf Building, Pittsburgh, Pa.

J. D. Lykins: Would you discuss the rust and oxidation characteristics of bentone greases in the presence of water?

D. H. Compondu: As far as the rusting is concerned, bentone is probably in the same class that any other grease would be if you do not use an inhibitor. This is probably the worst characteristic of the uninhibited bentone lubricants. Probably the inhibited bentones are as good or better than the normal grease would be.

Oxidation is limited by the oil used in the particular bentone lubricant we have reference to. The presence of water does not affect the lubricant at all.

Maurice Reswick: Do you depend on the oil content for the plasticity, and if so what happens when at the higher temperatures all the oil evaporates?

D. H. Compondu: That is why I mentioned the fact that these lubricants are as good or better than anything up to the oxidation point of the oil. That would depend on what type base oil you use in the material.

George Findlay: You said that your bentonite

greases would hold up to 15 per cent of their volume of water. Will you tell us what effect that water in the grease would have on the grease at high temperatures?

D. H. Compondu: The question was what effect would the moisture content, or the saturation of the bentone have at high heats. What actually occurs in any application we have thus far tested in a steel mill is that it merely flashes off and the material reverts to the original percentage. There seems to be no difference in the penetration or lubricity, and in heating to high temperatures, the water flashes off and leaves the same appearance that you had before the water was absorbed.

T. L. Corey: You mentioned the use of the bentone greases in high temperature applications. What temperature did you have in mind? What maximum temperature is used with these greases?

D. H. Compondu: To put it in another way, what is considered high temperature is this. We have successfully lubricated at 1500 F with this grease although it is not recommended. I would say somewhere in the neighborhood of the flash point of the oil is as high as I would recommend going.

T. L. Corey: That would not be over 500 F, would it?

D. H. Compondu: I would say a temperature of 500 F would be all right. However, in some instances if the grease is subjected to open flashing and direct heat, there is more rapid oxidation, naturally than if it were in an enclosed bearing and here you will get much better results.

Maurice Reswick: Would you recommend it for anti-friction bearings?

D. H. Compondu: Yes. We have recommended it in several instances for bearing applications and have found that it worked out very successfully. One thing that must be kept in mind is that the proper grade should be selected for this usage, and that normally if you are using a No. 2 soap base grease, you would go to a lighter consistency bentone lubricant because of the non-bleeding characteristic.

John P. Critchlow: Have you run any wheel bearing tests or other anti-friction bearing tests on bentone greases, and if so, how do the results compare with conventional soda-type anti-friction bearing greases?

D. H. Compondu: We have successfully passed various wheel bearing tests with varying results, most of them better than the conventional greases.

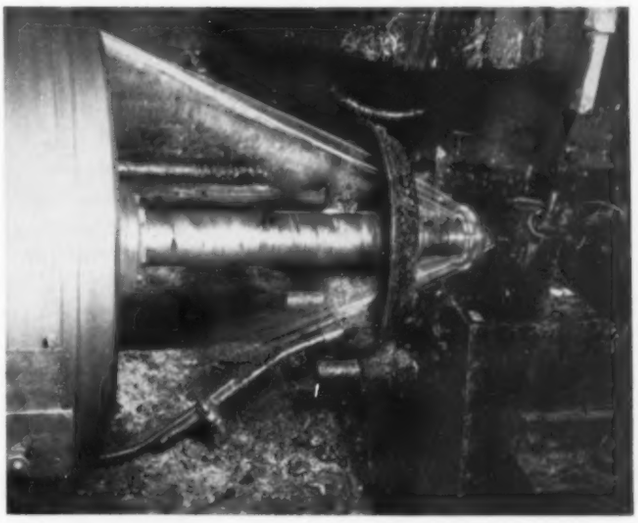
Wire Rope Lubrication

By C. H. LAYTON
Assistant Chief Rope Engineer
Hazard Wire Rope & American Cable Div.
American Chain & Cable Co., Inc.
Wilkes-Barre, Pa.

. . . . lubrication of wire rope should not be considered an expense, but rather an insurance . . . .

▲ THE days are gone when manufacturers and most wire rope users were content to apply just any old grease or lubricant available to wire rope and consider the matter closed. Considerable studies have been made in the past years regarding the value of wire rope lubrication and the proper types to be applied. These studies are continuing and will possibly continue to be made as long as wire rope is used. The problem of proper lubrication is complex and extremely interesting and covers considerable scope within the manufacturer's plant. It is pretty well recognized today that the lubrication applied during the manufacture of the wire rope cannot possibly last during the entire service period unless replenished by the user. However, because of the present day competition between the various manufacturers, it is imperative that the rope be laid up with the best available product so that the user will at least start out with a product of highest quality and lubricated in the best way and with the best material. Today there is much rope manufactured in a manner classified as special or tailor-made. This specialty in

Figure 1 — Lubrication at the stranding machine is applied with a rotating disc. Core of lubricant completely encloses all wires, assuring complete coverage.



manufacture not only involves materials from which the rope is made but the kind and type of lubricant used during manufacture. Special lubricants are used and their choice depends upon the intended service of the wire rope. What may be perfectly satisfactory on one installation might be far from satisfactory on another operation.

The problem of lubrication may be set up under two general classifications each of which can be sub-divided a number of times. The first of these is lubrication in the plant during the wire rope's manufacture and the second is the proper lubrication of the wire rope in service.

Each wire rope manufacturer uses what, in his opinion, is the most suitable for the service. Since developments are being made very rapidly, this is naturally subject to change from time to time. It is agreed, however, that proper and sufficient lubrication is needed and that it should be of such a character to form a base for field applications. There are several qualities which should be possessed by all lubricants regardless of the service, namely; (1) ability to adhere firmly at all times, under heavy rubbing and scraping action of the rope against sheaves and drums, (2) ability to penetrate between the strands to the core and to impregnate the fibre center, (3) freedom from acids, alkalies or any other harmful ingredients that might pit or corrode the wires, (4) ability of the film of lubricant to spread itself; it must be flexible enough in its character so that in passing over sheaves it will not strip off or open up to admit moisture, and (5) it should be able to set up on the rope so that it does not continue to flow after it is applied but still have the characteristics of non-evaporation or becoming hard and brittle upon prolonged exposure to air and cold weather or fluid in hot climates.

All of these characteristics are desirable from the manufacturer's standpoint and also by the user. The manufacturer in addition to wanting to insure proper protection of the material during transportation and while in storage, also has considerable interest in providing the user with a lubricant which will function for the longest possible time after the rope is put into service.

In some services, additional applications of lubricants are considered impractical by the users. In others where the rope is relatively long-lifed, additional applications must be made in the field.

The lubrication of wire rope is of vital importance to the safety and economy of the installation or operation on which it is employed. It is not wise to consider wire rope lubrication practices non-essential. Every user should realize that any apparent saving effected by neglect of this most important phase of wire rope maintenance will actually result in a loss due to shortened rope life. Too often this is a direct cause of an accident and every wire rope user should be cognizant of these facts, but it is surprising to note the apparent lack of interest in this subject among a great majority of wire rope users.

In setting up and introducing any proper lubrication practice, it is first necessary to analyze existing conditions. If an old installation or a new one, it is best to institute a study and examination of the rope in service or a careful inspection of a discarded rope to determine the type of deterioration against which to guard. This kind of approach is necessary since in many cases the safety of men, materials and continued production depend upon the wire rope which has been thoroughly lubricated and properly maintained.

Briefly, wire rope is made up of a number of steel strands numbering six to eighteen and each strand consists of from seven to forty-six wires laid in geometrical patterns to form a solid and compact member. The flexibility of the strands and the finished wire rope is dependent upon the number of wires in each strand. Also, the selection of the various types of rope is dependent upon its intended use and the conditions encountered in its use. The 6x7 wire rope is relatively stiff and is used in those services where bending characteristics are secondary to hard usage and heavy wire wear. The 6x19 classification, which is the most popular and most generally used, is an intermediate rope construction between the 6x7 and 6x37 classification, the extra flexible wire rope being the 6x37 and 8-strand rope.

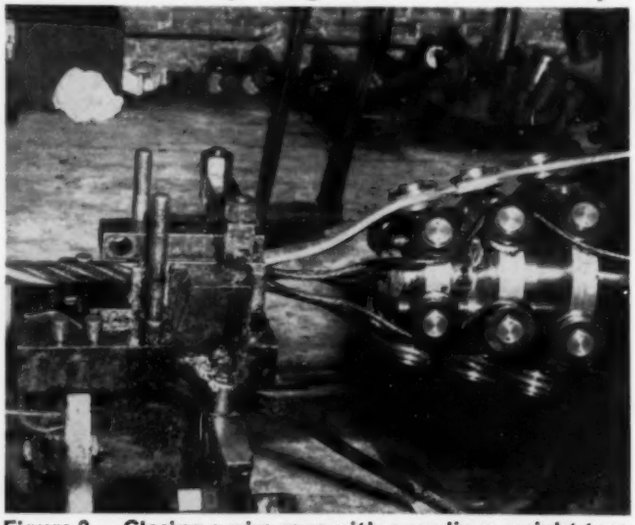


Figure 2 — Closing a wire rope with a medium weight type of lubrication. Note individual strands are well covered with lubricant. The IWRC is also well lubricated.

It is therefore readily apparent that the amount of reserve strength of any wire rope varies greatly with the construction and is dependent upon the pattern and number of broken wires. For instance, a 6x7 rope construction suffers a loss of its reserve strength by 1/42 for each broken wire, whereas it is 1/114 for the 6x19 and 1/222 for the 6x37 classification. It is therefore imperative that the wire rope user or the person responsible for wire rope maintenance be thoroughly acquainted with the characteristics and constructions of the wire rope under his jurisdiction. However, this balance can be completely upset if proper lubrication is not maintained and reserve strength becomes an indeterminate factor which is impossible to predict.

Since wire rope is made of a multiplicity of individual wires, it can be said that there are two groups of wires to be considered. There are those on the outer surfaces which are visible and those on the inside which are invisible at all times. Fortunately, the outer wires of the wire rope are those exposed to abrasion, corrosion and maximum fatigue stresses, and in a well-maintained rope are usually the first to wear out or fail. The inner wires, because of the protecting shield, remain intact and form the reserve strength of the wire rope. Because

of this feature, it is usually possible and practical to set up inspection practices for wire rope so that its condition can be closely approximated at any time. However, if, from lack of care or improper lubrication practices, other factors such as corrosion are present, all rules for the safety of the installation becomes useless and inadequate and it is impossible to determine the wire rope condition.

Wire rope has often been referred to as a mechanism similar to a machine. In truth, the difference between the two is very small. A wire rope is designed with extreme care and micromatic accuracy, its component parts are drawn to tolerances of 0.0005 in. to 0.00025 in. and during its operation when bending about a sheave there is considerable movement of these parts in relation to each other. Bearing surfaces are present throughout the entire length of a wire rope and each and every wire has a point of bearing with at least two or more other wires, depending upon the rope's design. When the rope is new these bearings are points of tangents of the round wires. Anyone familiar with lubrication and machinery, and probably everyone is today, can appreciate the friction forces set up and the type of deterioration which can take place if these bearing points are not properly lubricated. It should also be kept in mind that the usual design practice is to figure wire rope safety factors at the lowest possible figures, and that since wire rope is made of the strongest of steels the rope stresses are usually high and result in unusually high bearing stresses within the rope itself.

There can be no doubt that the need for the proper type and lubrication practice is present and required to insure safety of the operation and assure the ultimate in rope service.

Wire rope corrosion is one of the chief sources of rope deterioration and one of the most difficult to detect. Because of the character of the material from which wire rope is made, usually plain high carbon steel, which through its processing methods is highly drawn and of high strength and becomes especially susceptible to this type of deterioration. The corrosion which occurs inside the wire rope is not often easily found. This is sometimes due to the type of lubricant used, which on applying does not penetrate into the inner portions of the wire rope but sets up on the surface sealing any moisture present within the rope and effectively prevents proper observation of the rope's condition. Even by cleaning a section of the rope thoroughly, it is difficult to determine whether corrosion is present, particularly if the rope is of large diameter or under stress. However, surface pitting observed under such circumstances is an indication that internal corrosion may be present. It is impossible to tell, however, the progress or extent such deterioration might have made. In such cases, it is the usual recommendation to remove the rope from service and have samples of it inspected and tested by competent persons.

Figure 3 — Additional lubricant is being applied at closing machine dies. Individual strands and wires are already coated with lubricants.

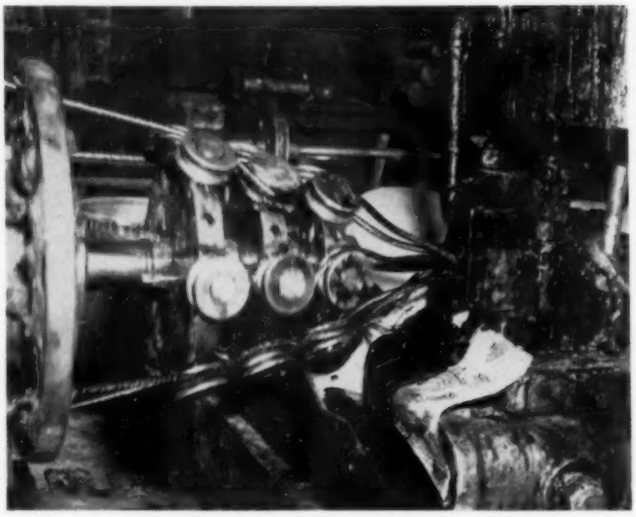


Figure 4 — Illustration shows method of further treating pre-lubricated fibre cores as they enter wire rope closing machines.

Wire rope is fabricated with either of two types of core. Depending upon the service intended, either a core of fibre consisting of sisal, jute or cotton or an independent wire rope core made from steel wires and commonly called IWRC is used. Other materials such as paper and plastics have been tried and used without general acceptance or complete satisfaction. When fibre cores are specified, the practice today is to use pre-lubricated cores for all operating ropes. Through the mutual cooperation of the cordage manufacturers and the wire rope manufacturers, the standards as to the type and amount have been agreed upon. The lubricant used in addition to regular cordage oils is a material of neutral reaction plus additives for the preservation of the rope against mildew, fungus growth, etc. The amount runs about 16 per cent maximum by weight of the fibre. This assures a well lubricated core of proper balance of fibre and lubricant upon which to build. Even the above amount is in excess of the amount that can be retained when the pressures of the main strands are imposed upon the core. The IWRC which as its

name implies is an entirely independent wire rope is lubricated during its fabrication with the same type of lubricant used in the making of the main rope strands.

Proper lubrication of the fibre core initially is of tremendous importance with regard to the safety and performance of the wire rope. Present day methods assure uniform and even distribution of the lubricant throughout the entire core and eliminate the possibility of surface treatment only, a practice used a few years ago when the centers were merely pulled through a bath of hot lubricant.

In the fabrication of the main rope strands selection of the type of compound must be made. As a general rule, the intended service requirements of the rope usually determine the type of lubricant to use. For ropes of the coarser construction such as 6x7 and 6x19 classification of sizes ¾ in. and larger, heavy black compounds are selected. The smaller sizes and more flexible ropes are lubricated with either light-weight black compounds or petrolatum or other special compounds developed for definite service requirements. The 6x7 and 6x19 constructions are intended for the more rugged service requirements such as general utility rope, oil field and mining ropes. The other class rope is for crane service, shop hoists, elevators and aircraft control and slings, and many other services where the heavy type of lubricant would be of considerable disadvantage in either handling or convenience.

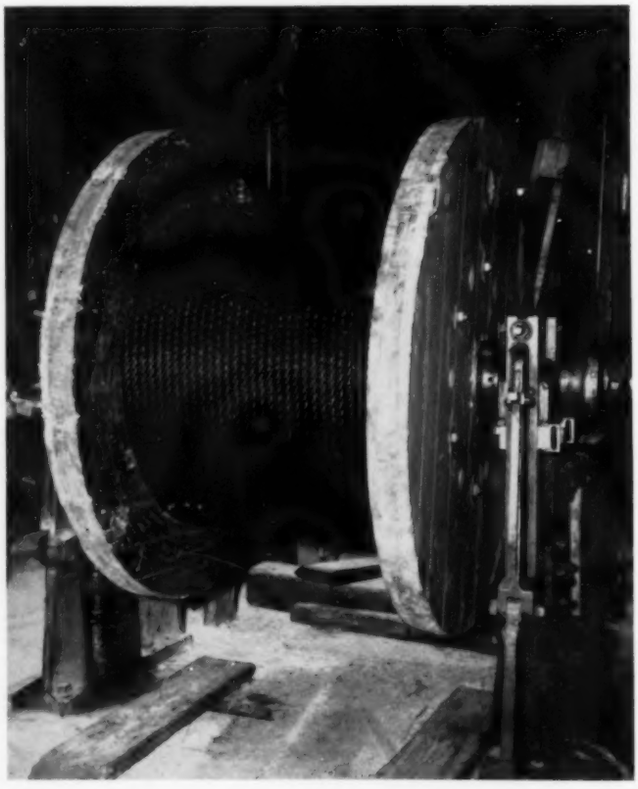
The application of the lubricant during the fabrication of the main rope strands is accomplished by either a rotating disc or pump which places the compound just at the point of twist of the wires prior to their entrance into the strand dies. This assures each and every wire a full coating of lubricant and also fills all the voids in the completed strand. Ropes which because of their intended service or exposure require an excess of lubricant are also given an additional coating at the rope closing machine. Also, in practically all cases, the fibre cores are pulled through a bath of compound prior to the laying of the main strands about it. The additional lubricant applied at the closing machine fills all the strand valleys and gives the rope an appearance of a black rod rather than a fabricated member of 42 to 222 individual wires.

The application of wire rope compounds for rope in service has been written about and discussed in many papers. The methods used have been fairly well established and there have been no radical changes in recent years. Briefly, these consist of various box-type constructions that enclose the rope allowing it to travel through a bath of the lubricant, brushing or swabbing the compound on the rope while it is wrapped about a drum, and the continuous drip or intermediate drip method where a light-bodied lubricant is usually applied at some point of the rope where flexing is taking place, thus allowing the penetration to be somewhat better than other methods mentioned.

The selection of lubricants for field applications poses one of the major problems for the wire rope manufacturer in his position as counsel to the wire rope user. In many cases the problems to be overcome vary, and no single or simple practice can be established to take care of all conditions and requirements which are present. In general, a field-applied lubricant should possess most of the characteristics previously outlined for plant compounds. However, there are many factors which govern just which type can or should be used for the best results. In the plant it is easier to apply heavy based compounds which contain the maximum of protector elements than in the field. However, this is a general conclusion and should not be taken as eliminating the many lubricants now available which can be purchased and which will give reasonable protection even though field applied.

On one point there is general agreement that in applying field lubricants the best results are obtained if the rope is fairly clean and dry at the time of application. A dirty rope is usually in such a condition that the dirt seals the valleys and wire voids to the extent that the additional lubricant is merely a surface application. There is general agreement between the recommended methods of lubricating wire rope on the fact that the lubricant should have sufficient body whether applied hot or with a thinner that upon cooling or evaporation will provide good protection to the wires. One of the most important considerations of field-applied lubricants is to provide protection to the fibre core and to keep replenishing the lubricants in this member. The entire structure of the wire rope is built upon the fibre core and it is most important that it should not be allowed to become dried and compressed to a point where it offers no support to main rope strands. Also, since fibre has a natural affinity for absorbing moisture without proper protection, this could easily become the focal point of initiating corrosion. If this member is properly saturated with a good compound, there will be no room for the retention of moisture.

Figure 5 — When all parts of the wire rope are well lubricated, all spaces between wires, strands and cores are completely packed with lubricant.



Examination of used sections of wire rope have conclusively determined that all other things equal, the condition of the fibre core will in the end determine the amount of service and safety of the operation.

It is an established fact that wire rope can be maintained in a lubricated condition by any of the methods discussed. The efficiency of the lubricating practice depends a great deal upon the frequency of application and the faithfulness with which it is carried out. Unless this is followed throughout the entire service period, it is possible that the usefulness of the entire program can be lost and the result is short rope service, questionable safety of the operation and loss of time and money. A wire rope cannot be fully restored if deterioration has been allowed to develop, regardless of subsequent lubrication practices.

This paper is of a general nature because of the wide scope it must naturally cover. We do not intend to compare the qualities of the lubricant now available on the market today. We wish to point out, however, that considerable interest has been aroused and the major lubricating companies have spent considerable time in research to improve their product for this purpose. We believe that these studies will continue with resultant improvements and developments.

During this period of national emergency and preparation for defense, the subject of wire rope lubrication, which has always been of importance and interest to wire rope users, should now be of greater interest since it is one method of increasing production by improving rope performance and insuring efficient plant operation. Wire rope may or may not be a critical item today; however, during the past war many of its users found it particularly difficult to obtain, and those not in the habit of carrying sufficient inventories experienced many trying moments. Wire rope is one item upon which practically all industries rely in some way or another for procurement of their finished products or as a part of their product. For this reason such an item must be given its rightful consideration, and proper means of insuring its most economical service must be taken.

The cost of a lubricating program, then, and the effort made toward its maintenance, must be considered not as *expense* but *insurance* which all wire rope users should carry.

DISCUSSION

PRESENTED BY

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DONALD E. WHITEHEAD, General Lubrication Engineer, Crucible Steel Co. of America, Pittsburgh, Pa.

FRANK L. GRAY, Lubrication Engineer, United States Steel Co., Gary Works, Gary, Ind.

A. E. CICHELLI, Lubrication Engineer, Construction & Engineering Depts., Bethlehem Steel Co., Sparrows Point, Baltimore, Md.

C. H. LAYTON, Assistant Chief Rope Engineer, Hazard Wire Rope & American Cable Div., American Chain & Cable Co., Inc., Wilkes-Barre, Pa.

W. M. Schuck: It is admittedly true that any discussion of wire rope lubrication must be general in nature especially by a representative supplier of cable whose products are used under hundreds of widely varying conditions. However the speaker wishes to present for discussion two additional thoughts upon this subject. First, Mr. Layton states that every effort is made to adequately lubricate the wire, strands, and core of wire rope during the process of manufacture. This practice definitely extends the life of the wire rope in service and the actual application of a lubricant is relatively easy during manufacture. After this same rope is in service, however, any additional lubricant applied must possess the dual ability to penetrate and lubricate the core fibre as well as form a semi-hard impervious outer shield around the surface strands. Would it not be advisable for the cable user to apply two lubricants to the cable when lubricant reapplications are required, one very light viscosity material that would penetrate to the fibre core easily, to be followed with a heavy shield type of material for protection of the outer surfaces?

The second query concerns cleanliness. It is almost a general practice to relubricate wire rope without making any attempt to clean the cable surfaces of accumulated dirt and dust contamination. In servicing any other machine operating within our plants in need of a complete resupply of lubricant, the machine would be cleaned of all dirt and sludge deposits before the new oil or grease was applied. Can the same good practice be extended to include wire rope? Is there a practical and feasible method of cable cleaning available to the wire rope user?

R. A. Kraus: Those of us in the field realize the value that can be obtained by relubricating wire rope in service. This applies particularly to the more expensive, larger and longer ropes, such as blast furnace skip cables and bell cables. Experience over the years has shown that it is possible to increase rope life by about half again by the application of suitable lubricants to the rope during service. The problem of cleaning wire rope under service conditions is a rather complex one. People have suggested steam cleaning in service by directing steam jets onto the cable during operation. Difficulties can result from this practice. While this procedure adequately will clean cables, it is accompanied by the disadvantage of driving moisture into the core with subsequent internal damage and shortened rope life.

In those instances where we automatically lubricate cable equipment, our practice has been to use a relatively light petroleum product that is capable of penetrating to the core of the cable and is also sufficiently light to reduce the extent of dirt build-up on the outside of the cable. Heavier products frequently will not penetrate to the hemp center and further are the cause of excessive build-up on the exterior of the cable.

In addition, heavier products cut back in viscosity with a volatile solvent are useful for nonautomatic

applications. They can be sprayed, brushed or dipped onto the cable. Further they are capable of penetrating into the strands and provide a satisfactory water resistant external coating as they set up or harden.

It has previously been suggested to first apply a light lubricant to the cable in an effort to secure adequate penetration into the core and then apply a heavy product for an external shield. The difficulty here is in relubricating the cable. It will require first a thorough cleaning to allow the light product to penetrate to the core and if a steam cleaning job was used, the light product will have to have water displacement properties to prevent internal rusting. Secondly, satisfactory retention of a heavy residuum product on a surface previously wet with a low viscosity oil is extremely questionable. The continuous automatic use of a light product should provide the desired protection at a lowered total cost.

A few remarks should also be made regarding the manufacture of cable and the quality of the lubrication applied at this time. Experience has shown that it is not uncommon to find hemp cores on new cable to be bone dry for all practical purposes. These represent instances where the lubricant in the core is actually squeezed out by the closing operation through the die. Inasmuch as there are many smaller cable applications where relubrication during service is rarely practiced, the need for adequate lubrication in the cable as supplied is a definite requisite.

Donald E. Whitehead: Wire rope is a big item when you consider its wide application in the steel mills including their cranes, mine operations, steamship operations, and so forth, and it has been my observation that lubrication of wire rope as it is used in the steel industry has been more or less neglected compared to other avenues of lubrication.

The thought has occurred to me as we have worked with antirust oils, observing their penetration characteristics, their film strength, their self-healing ability, and stability that the spraying of lubricants of this nature on wire rope might enhance the subject of wire rope lubrication to a large degree. The oils that I refer to particularly are the solvent cutback polymerized types, and it is my particular thought that I would like to see the wire rope manufacturers themselves take a stronger leadership in the direction of wire rope lubrication in the steel industry.

Frank L. Gray: One idea in the manufacture of cable is to inject colloidal graphite during the manufacture of the cable. Is there any background on that subject?

A. E. Cichelli: I would like to interject just one thought from the experience of our own plant, (recognizing the importance of core lubrication, of course), the fact that the life of the rope is largely dependent on what the user does at his own plant. We find at Sparrows Point that very good life can be achieved on blast furnace skip ropes as well as on open hearth crane ropes by the simple expedient of daily inspection, and if necessary, daily lubrication.

Were it not for this practice and the use of large diameter sheaves where possible, it has been demonstrated in Sparrows Point that the best results could not be obtained.

C. H. Layton: In reply to the question regarding the advisability of using a light and heavy lubricant for the purpose of relubricating wire ropes in service, we have often recommended that such a practice be followed. The light oils usually act as a flushing and cleansing agent and have good penetrating values. We also recommend that heavy lubricants be applied as a prevention of surface wear and corrosion when the wire rope is used in operation around sheaves and drums. This practice is not new, but it is extremely difficult to induce wire rope users to spend the time and money for such rope treatment.

In answer to the second question regarding cleaning a wire rope while in service prior to relubrication, we would comment that there are several ways of accomplishing this. We know of one of the major gold mines in Colorado where their mechanic has developed a unit for cleaning and relubrication of their wire rope. I believe it employs steam and air and the rope is relubricated as soon as it passes through these two cleaning agents.

Another method often used is the use of light oil to act as a flushing agent. This is applied by either wicks or the continuous drip method. I have reference to a coal mine operation where the shaft was completely filled with fine coal dust. This caused a collection of dust to gather on the wire rope, especially when the rope was new or relubricated, and completely packed the strand valleys with a compound composed of coal dirt and lubricant. The wire rope after a few weeks' service looked like a steel rod. The compound left on the rope served no good purpose, whatever, and acted as a shield preventing penetration of subsequently applied lubricants. The problem was overcome by erecting a continuous applicator at the head sheave. This is the point where in bending, the wire rope opens up slightly and the most efficient penetration is obtained. With the use of light oil, the rope was kept clean and well lubricated. When a sample of this rope was sent in for inspection, it had the appearance of being only slightly used, whereas previous ropes showed internal wire failures, corrosion and a completely dried out fibre core.

The practice of using prelubricated fibre cores for wire rope is practically universal with a majority of wire rope manufacturers. Wire rope centers are treated by the cordage manufacturers so that complete penetration and coverage is obtained. I believe that much of the lubricant noticed on the wire rope surface, and thought of as being squeezed out of the fibre core, actually is an excess applied by the wire rope manufacturers. It is the usual practice to give the fibre cores a surface treatment by pulling them through a bath of lubricant just prior to their passing through the closing machine.

Colloidal graphite, zinc and lead powder have been used as additives to the regular wire rope lubricants to some extent, and with what appears to be considerable satisfaction. We use those materials on the theory of adding surfaces that the grease or lubricant will adhere and cause to be retained in the wire rope. Many of these specially treated wire ropes have been used throughout the Rocky Mountain district.

We would also like to point out that the wire rope manufacturer is in a very highly competitive field, and any request by the wire rope user for any particular type of lubricant or none at all, is usually complied with and the wire rope is produced as the user specifies.

PRODUCTIVE ELECTRICAL MAINTENANCE

By A. D. KING
Superintendent, Detroit Service Shop
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. . . . the best way to attain increased production is to remove production barriers such as mill breakdowns by preventive maintenance . . . .

▲ IN these days of extreme emphasis on maximum production, let us pause for a moment to look over our maintenance practices. Is your maintenance department organized on a creative or productive basis? Or, does it operate on a defensive or subject to call basis, subject to call to correct trouble after the damage has already been done and the mill is down, and valuable production is being lost.

"Maintenance" can no longer be the stepchild of production; the necessary evil to carry on repairs after something breaks down.

If full production is to be achieved, maintenance must be recognized as a full fledged partner of production. With this recognition and authority, your maintenance department will be operating on a creative and productive basis, and your mills will certainly produce more tons of steel than ever before.

Industry in general, and the steel industry in particular, has a tremendous job ahead in the way of supplying the current demands for their products. There is an unprecedented demand for steel to build a defense machine that will cost billions and billions of dollars. The very thought of preserving and maintaining a large defense machine, leads one to believe there will be a heavy demand for steel and other products for many years to come. At the same time, the demands of the civilian economy will remain high, due to the continued expansion of this market. It seems that the cry is for more production, when our present facilities have already seemingly reached their capacity.

In the good old American tradition, industry can usually expand their facilities fast enough to take care of any demands. However, the possibilities for immediate expansion are limited due to the limitations of the very facilities that are required for expansion. Structural steel is in heavy demand; electrical and mechanical devices are months and years away, when thinking in terms of new equipment for expansion.

Until just recently, the manpower situation has been quite critical and we will likely find a shortage of manpower facing us again. The armed services will continue to take many of our young men and women for military service. We, therefore, cannot expect too much immediate relief due to expanded facilities. Expansion is proceeding on a long-range basis. Now is when we need every extra ton of steel possible.

With the tremendous demand for steel, the industry must find new ways to create extra production from their present facilities. The best way to accomplish this task is to remove all production barriers that interfere with the full operation of all present facilities. One of the most annoying and costly barriers to full production is machine outage due to breakdowns. I am sure most mills would be amazed if they would translate all outages into tons of steel lost due to unplanned outages. They would be further amazed to analyze the outages and find that most of them could be greatly reduced in duration or eliminated entirely, by following aggressively and effectively a "Productive Maintenance Program."

Most machine failures give plenty of warning of their distresses, if an alert maintenance department is on the job and picks up the signal. Many outages can be eliminated entirely or delayed until a more opportune time, by simply taking care of the small troubles promptly that invariably develop into major and costly outages. It is necessary to anticipate trouble and actually correct it before extensive damage is done, requiring a major outage for repairs and causing extensive production losses. Most unscheduled outages can be eliminated by careful investigation and inspection, and proper preventive measures.

Management must recognize that the maintenance department actually keeps the mill running. When the mill stops or trouble develops, it is the maintenance department that is put on the spot to get the mill back on the line without delay, and usually, at the same time, explain why the outage occurred in the first place. Management must recognize the responsibilities of maintenance and give them the necessary authority to carry out their job in the best interest of uniform and maximum production. Management must recognize maintenance as being equally important as production.

Production may set bogies, pay bonuses and scream for more tonnage, but this extra tonnage will not come from a crippled mill that is too sick to deliver normal tonnage; a mill that is crippled because it has not been maintained properly to give full production; a mill that has not been properly maintained, because management would not allow the maintenance department sufficient time to do a good job of preventive maintenance.

In too many cases, the maintenance department receives only "lip service" for their efforts and are not given the authority to see to it that the machinery is kept in tip top operating condition. In too many cases, the maintenance department is given only the crumbs when management is dishing out the money for operational expenses. You never seem to hear too much about production bonuses or high praise around the maintenance department for overtonnage, when in reality these are the people who actually make such production possible. Only too often we hear the operators say, "We will fix it when and if we can get to it" or "We will fix it at the next down time" or "Just let the next turn worry about it." This type of operation and maintenance invariably ends with a major disaster and a costly outage.

For maximum production, the maintenance department must work hand in hand with production, with the necessary authority to keep all equipment in first class operating condition. With this type of operation, all hands are working for the same cause, uniform uninterrupted maximum tonnage.

What are the specifications for a sound "Productive Maintenance Program?"

First — An adequate staff of trained maintenance men. Men that are fully trained and qualified to carry on thorough inspection and test work. Men that can actually detect trouble in the making and correct it before it develops into a major failure. Men that are genuinely interested in their work because they like the work, the pay, and the responsibility associated with the job. This is no job for a man that does not fit any place else in the plant. This job requires wide-awake, aggressive, conscientious men who can best be developed right in your own plant. The organization should be such that the work can be performed without too much overtime, as tired men are not alert, and as a rule are not good workmen.

Second — The maintenance men must be armed with the most modern tools, instruments, and instructions and data to enable them to carry on a complete and scientific investigation on all types of mill equipment. The maintenance men must perform regular routine tests and checks on all mill equipment to detect any impending trouble. A complete detailed record should be maintained of every test and inspection, to establish a historical record of the condition of the particular machine involved. Any irregularities or unusual findings should be red-flagged for close observation or further investigation.

Definite planned outages must be scheduled at intervals to make minute inspections of all mechanical and electrical parts that cannot be inspected while in full operation; to carry on minor repairs that have been found necessary on previous inspection, and make further determinations on the necessity of planning or performing a major repair operation, or replacement, as the case might require.

With a scientific analysis and approach to your maintenance problems, all major outages or repairs can be planned well in advance and performed with a minimum loss of production; all materials can be accumulated and placed on the job; production schedules can be altered to relieve the pressure on the mill, and adequate personnel can be organized to properly and quickly perform the necessary repairs or replacements, as the job may require. Whereas, unexpected failures always occur at the worst possible time causing unnecessary equipment damage; costly production losses; lost man hours of production personnel; premium pay for maintenance men working overtime to repair the damage. Planned outages will consume much less time and cost less production than unplanned outages.

An adequate stock of mechanical and electrical spare parts provides excellent insurance against prolonged outages. A few dollars invested in these items will pay big dividends when failures occur and replacement parts are needed. Spare bearings, brushes, gears, contacts, coils, armatures, are sometimes needed to make emergency repairs or replacements in order to keep the mill running. All spare parts should be properly catalogued and located so that they can be found when needed.

Management must provide sufficient budget to allow the maintenance department to operate on a productive basis and not make it necessary for them to fight for the money needed to keep the mill in order for maximum production. In too many cases, maintenance work is considered a necessary evil and only receives a mere pittance, with which they are expected to keep the mill producing the required tonnage. With a stingy budget, the maintenance department will be forced to operate with limited manpower and insufficient supplies. This type of maintenance is responsible for poor mill operation.

The maintenance department must know the true productive worth of every unit in the mill. With this knowledge and charged with the responsibility of meeting the tonnage requirement, an alert maintenance group will work their hearts out to meet the schedule. Without the responsibility and without the schedule, the maintenance department is only receiving secondary consideration and in all probability, will only do a second class job. This type of maintenance is not productive; it is the good old-fashioned type of defensive maintenance.

The maintenance department should maintain a complete record system for each and every unit in the mill. This record should show unit, identification, and location. It should show the productive value of the unit. It should show complete repair parts information such as, identification of parts and where such parts are stored. Inspection schedules, test data, repair schedules, and outages with causes should be accurately recorded. With these historical facts on each machine, the maintenance department can pursue the maintenance problems from an intelligent approach. They can analyze each failure or outage and determine the cause of the trouble. If failures become repetitive in nature, a complete study can be made to determine the best corrective measures.

The maintenance department must follow a "Productive Maintenance Program" and handle all maintenance and repair work with the idea of producing more tons of steel; in fact, it should be their job to see to it that all machinery is available for full schedule operation at all times. When the full responsibility of keeping the mill running is placed squarely up to the maintenance department, they will rise to the challenge and see to it that all equipment is kept in first class operating condition.

With a "Productive Maintenance Program" you can actually avoid unscheduled breakdowns, reduce outage time, and actually increase production with your present facilities. You will save man-hours, capital equipment, and in many cases, personnel injuries.

EQUIPMENT MAINTENANCE

Dirt, heat, and poor maintenance, are true enemies of your mill equipment and maximum production, and, every mill has some of each.

Dealing with these culprits individually, dirt causes unnecessary wear of moving parts such as, bearings, commutators, packing glands, gears, etc. It restricts and contaminates coolants and lubricants. Many bearing failures are directly chargeable to dirt; others are chargeable to restricted coolants. Dirt restricts and contaminates cooling air, causing air cooled equipment to over-heat and eventually fail in operation. In many cases, dirt serves as an electrical path leading to the failure of motors, generators, switches, controllers, cable and wiring.

Our safety records indicate that dirt and contamination are still responsible for too many industrial accidents. Good housekeeping and cleanliness will pay dividends in the shop as well as in the home.

There are acceptable cleaning fluids on the market that will assist materially in doing a good housekeeping job around electrical machinery and mill equipment. The use of carbon-tetrachloride for cleaning purposes should be discouraged due to the potential health hazards associated with its use.(1)* The use of compressed air, free from moisture, if carefully used will remove loose dirt from machinery and electrical windings. However, in many cases, considerable damage can be done if care is not exercised, particularly on old windings that are dried out and cracked.

"Heat" is the natural enemy of most electrical insulations and should be dealt with accordingly. It also requires close consideration on mechanical parts. Where close operating tolerances are required, every precaution should be exercised to operate electrical machinery within their temperature rating. When apparatus is operated above its rated temperature, the over-all life is usually reduced. Consequently, operating temperatures are an important factor when inspecting and analyzing operating conditions. Temperature should have considerable influence upon inspection and repair schedules. Temperatures can usually be held within good safe operating values by providing plenty of clean ventilating air, surface coolers, and in some cases, refrigeration.

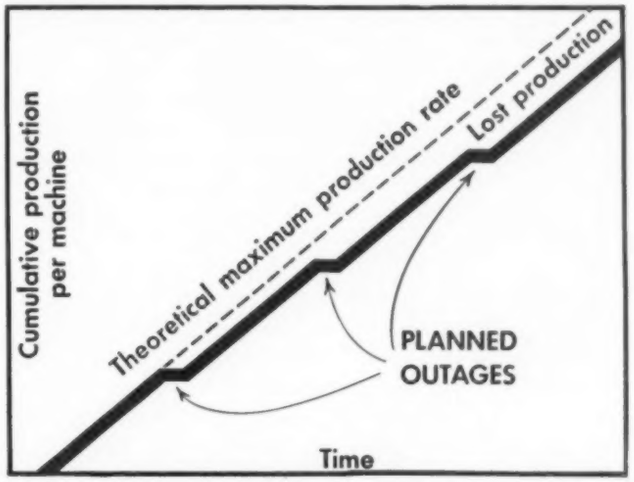
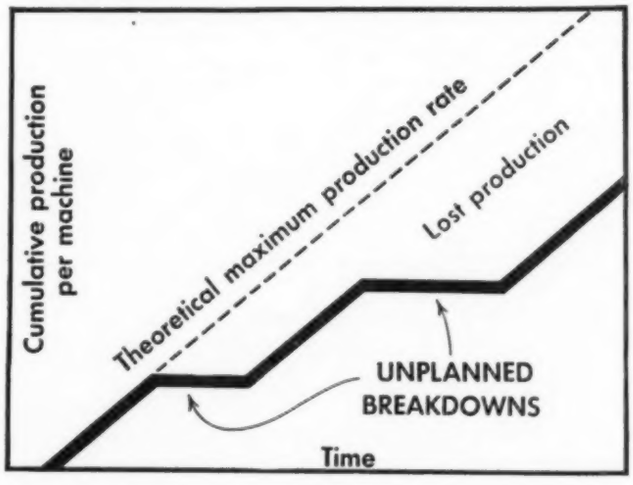


Figure 2 — With the planned outage as its key, productive maintenance aims to narrow the gap between actual and theoretical maximum production on the part of a machine, particularly those essential to continued output. Planned outages consume far less time than unplanned breakdowns, thus increase actual production.

Figure 1 — Unscheduled breakdowns continue to be a reality despite day-to-day routine maintenance efforts, resulting in production losses that can never be made up under today's round-the-clock operations in many plants. Without scheduled down-time at convenient periods, any maintenance program is inadequate.



Overheating of motor and generator coils causes insulation cracks, loose coils, wedges and a general rapid deterioration that can only lead to an early winding failure.

"Poor Maintenance" allows small troubles and natural wear of parts to develop into major outages. Only too often, a large important mill motor or generator will be seriously damaged for the want of proper attention — on a carbon brush, a loose connection, an oil ring or bearing, any of which could have been replaced or repaired in a few minutes time, at the right time. Many bearings, and sometimes motors are damaged by incorrect coupling operation which can be caused by poor alignment or incorrect lubrication. It is highly important that all moving parts with points of friction be given regular inspection to head off major trouble. It is, likewise, highly important that all current carrying devices be inspected regularly for overheating, for excessive wear, and deterioration. If these items

* Numerals refer to Bibliography at end of article.

alone are properly maintained, many major failures will be eliminated. Too many maintenance jobs are put off for a better time and, in many cases, develop into a major outage before that time arrives. Good rigid inspection and maintenance of all mechanical equipment will pay dividends in any plant or mill. Most failures of gears, couplings, shafts, bearings, and pumps can be charged to poor maintenance. With proper attention and normal expected replacement of parts, there is really not much excuse for this type of failure.

Due to the ever increasing use of electrical apparatus in the steel industry, it is of paramount importance that a rigid inspection schedule be maintained on all electrical equipment. Load and temperature conditions should be uppermost in the maintenance department's mind, as these conditions alone contribute much to the operating success, or failure, of the installation.

All windings should receive regular inspections and tests to determine their reliability for further operations, and corrective measures planned where necessary.

Large windings should be inspected for looseness in the slot, puffed coils, loose tie bands where used, cracked and dry insulation, and evidence of corona discharge on high-voltage machines. When these conditions are found, immediate steps should be taken to make the best possible temporary repair and plans should be started promptly for permanent repairs or replacements.

Insulation resistance tests of windings give an indication of the amount of moisture present in a winding, and also give some indication as to the cleanliness of the machine. Insulation resistance readings on low-voltage machines will indicate whether or not the machine will withstand a potential equal to that supplied by the test set. It does not give you complete assurance that the machine can be returned to service. It is not uncommon for a dry brittle winding, free from dirt, to show a very high insulation reading, yet the winding may be at the point of failure due to cracks and voids in the insulation. For best results from megger readings, an accurate record should be made of readings at definite intervals in order to determine the trend of insulation conditions.

Insulation tests should be taken on all windings before a hi-pot test is applied, and if moisture or excessive dirt is present, the winding should be dried out and cleaned before applying hi-pot test.

The routine hi-pot test is the only method of giving reasonable assurance that the insulation of a machine will withstand further satisfactory operation. Such tests should be of sufficient magnitude to establish a reasonable degree of satisfaction that the machine is capable of returning to service.

It is rather difficult to arrive at a fixed value for routine hi-pot testing, as the magnitude of the voltage to be applied is many times influenced by the apparatus in question; consequently, we have suggested a value of 1-1/5 line to line volts plus 400 volts. In the case of large Class "B" insulated machines, a value of 10 per cent higher than that given is the formula as suggested. (2)

HUMAN RELATIONS

There is no program nor plan in the world that will work successfully without a full measure of good human relations as the basic ingredient. The biggest task of industrial management today is to win back the full confidence of their employees and to establish in their minds, a feeling of peace, security, and respect for the very job that supports their own livelihood. This job is made doubly hard because the false prophets have had a field day in peddling dissention, unrest, fear, hatred, and bias in the very area where management has feared to work and, in too many cases, failed miserably. Your maintenance can only be as good as your human relations.

The trend of modern machine design is to build the skill into the machine and remove this responsibility from the operators. This naturally makes the machine and related controls much more complicated, and shifts the burden of successful operation from the operator to the maintenance division.

It should be repeated that the human element will determine the success or failure of any operation, and a good human relations program is absolutely necessary.

This program applies particularly to the maintenance department, and if aggressively and honorably followed, along with a "Productive Maintenance Program," you may be surprised to find your maintenance cost actually go down, while your production actually goes up.

BIBLIOGRAPHY

1. "*Potential Health Hazards in the use of Carbon Tetrachloride*," by H. S. Gibbs, M.D., National Safety News, June, 1951.
2. "*Over Potential Test for Armature Windings in Service*," by R. W. Wueseman, General Electric Review, August, 1950.

DISCUSSION

PRESENTED BY

WARREN E. HART, Superintendent, Electric Furnace Building, Ford Motor Co., River Rouge Plant, Dearborn, Mich.

A. D. KING, Superintendent, Detroit Service Shop, General Electric Co., Detroit, Mich.

CLARENCE E. BAXTER, Assistant Chief Electrician, Hanna Furnace Div., Great Lakes Steel Corp., Detroit, Mich.

STANLEY W. LUTHER, Engineer, Detroit-Edison Co., Industrial Power Planning Dept., Detroit, Mich.

HENRY KEISER, Assistant Chief Electrician, Blast Furnace Div., Great Lakes Steel Corp., Ecorse, Detroit, Mich.

Warren E. Hart: What are the ingredients of the cleaning fluid you referred to in the paper and, secondly, how often should a motor winding be cleaned?

A. D. King: The ingredients of the fluid, now commercially available, are 25 per cent metheline chloride, 70 per cent stoddard solvent, and 5 per cent perchlorethylene. How often should motor windings be cleaned becomes a question of inspection and condition of the windings. Windings should be cleaned no more frequently than necessary to remove the dirt. If the windings get dirty quickly, that means the cleaning periods, naturally, will be more frequent, whereas if it is on a

clean application, the periods can be extended further apart. That is pretty much determined by your inspection and your insulation testing procedure.

Clarence E. Baxter: Is there a safe way to store spare motor coils for a period of, say, five or six years without deterioration?

A. D. King: The exposure of motor coils to the atmosphere increases the rate of deterioration of the insulation due to oxidation and fungus growth.

There are approved methods of storing motor coils for extended storage, the prime point being to secure them from the atmosphere and prevent the oxidation and fungus growth that is supported by the oxygen of the air. This can be accomplished by storing in evacuated and sealed metal containers. There are other methods of wax treatments, either one of which are quite good, and your coils will keep well for a period of five years. In fact, I have seen them stored for a longer period than five years and they looked exceptionally well.

Stanley W. Luther: I would like to question the hi-pot of 1.25 line voltage plus 400 volts. Can this value be used successively without reduction and how often would you recommend such hi-pots?

A. D. King: The 1.25 plus 400 is a value slightly above the operating potential and in most cases, I believe, would cover the average recurring transient. This potential value itself, should not be damaging to a winding that was safe for operation. If the winding was at a condition where this value became dangerous, then the winding should receive attention in terms of replacement, because you are approaching a minimum safe value.

Henry Keiser: Mr. King, you mentioned corona discharge in high voltage winding. How would you check that?

A. D. King: That is a pretty good question, because you are chasing something a bit elusive. Corona actually is a flow of current caused by the potential between the winding and the ground of your machine or adjacent phases of your winding. Now a good easy way to detect surface corona is apply a dark-room high potential test and it will show up by a glow in a dark room.

There are devices and instruments being developed, and being perfected, that is making the problem of corona testing much more selective and, unless it is selective, the knowledge that it is present is not of too great value. The real important problem of corona is to determine if it is within the coils. It is reasonably easy to detect surface corona, which you can see the effects of on the surface or find by dark room hi-pot test. But the corona that is really damaging to the extreme is the corona within a coil, where there are voids within the interior of the coil, and you can not see that until possibly after considerable damage has been done. However, there are devices now being developed that will aid in even checking those points.

TRAINING MAINTENANCE PERSONNEL

By W. ROSS FISHER
Assistant Training Adviser
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Middletown, Ohio

. . . . training makes the man ready for promotion . . . . at Armco practically all supervision have come up through the ranks . . . .

▲ TRAINING is engineering to the nth degree, it is human engineering.

What is an engineer? One definition is: "An engineer is one who designs, or builds, or uses engines or objects of civil and military architecture in which engines or other mechanical appliances are extensively employed." By the same token a human engineer or a training man builds personnel, and uses them in maintaining his organization.

To operate a steel plant efficiently, safely, and at a cost that will meet competition, we must have equipment of the latest design; equipment that will last; equipment that will operate with a minimum amount of delays; equipment capable of turning out the maximum amount of prime product with a minimum amount of rejects; equipment that is well backed up with spares in case of breakdown, etc. The design and construction of such equipment is an engineering problem of a mechanical nature. When the construction program is completed and the wheels begin to turn, then it becomes the problem of the maintenance department to keep operations going. Modern machinery with its precision methods of control, needs highly skilled maintenance. No longer can the hammer and chisel man "fill the bill". "Training Maintenance Personnel" to the point of skill demanded by 1952 industry becomes a necessity and a problem in human engineering. Such engineering becomes the responsibility of training and maintenance departments, working hand in hand, so that they can impart to the organization sufficient

knowledge (both practical and theoretical) to handle all maintenance problems in an ultra efficient manner.

Our company's maintenance training program covers our shops, assigned maintenance, and power sections. In our shops we have a four year apprentice program. Candidates are very carefully screened, and the entrance requirements are quite rigorous. A candidate must have a high school education or its equivalent; must successfully pass mechanical comprehension, and I. Q. tests; and must possess a well balanced personality, as shown by the Bernreuter test. Upon acceptance he is placed on a 90-day probationary period. This gives shop supervision an opportunity to be sure the apprentice will be a satisfactory addition to the organization; and, in turn, gives the trainee the chance to decide whether or not he has selected the field he would like to make his life work. If, at the end of probation, every one is satisfied, then the candidate signs his indenture and becomes a full-fledged apprentice. So thorough and careful has been our selecting, there have been only one or two cases in several years where the young man has failed to pass the trial period. As an apprentice, besides getting his practical shop instruction, he is entitled to come to classroom four hours a week on company time for related theoretical training. For text material for

Figure 1 — Shop apprentices in classroom for related training. (Note: This picture was originally published as an I.C.S. advertisement in Time Magazine.)

the classroom part of his training, we use International Correspondence Schools courses compiled for his particular trade. The text material is in the form of lesson pamphlets, which are obtained from I.C.S. and assigned as needed. Upon the completion of the study of each pamphlet, a written examination must be taken and sent in to I.C.S. for grading. A complete record of his grades is kept and placed upon his employment record at graduation.

We have approximately 100 apprentices in all in our machine, weld, rigger, carpenter, tin, pipe, electric repair, and blacksmith shops, and in our round-house, electric construction and masonry departments. Setting up class-room courses for such a wide variety of trades would have been a gigantic task. However we found, after careful investigation, that I.C.S. had courses which, in a general way, covered our shop needs very well. For instance their machinist course covers lessons in mathematics from addition and subtraction through trigonometry and mechanics; lessons in all kinds of machine tools such as lathes, shapers, milling machines, etc.; gearing; blue print reading; drawing; economics; good English; etc., (71 lessons in all). The sheet metal workers course contains mathematics and English, as well as trade subjects; and a drawing course of 45 drawings covering most phases of sheet metal layout work. Our other shops have courses which cover their immediate needs in a similar manner.

On-the-job work schedules are set up, which are planned to give the apprentice experience in every phase of work in his particular shop. These schedules are followed as closely as is found practical. Careful records are kept by the training department of hours actually worked on each operation, and we see to it that the schedule is followed and that the apprentice is shifted around. In this way, when he graduates, he is not a one-operation specialist; but a mechanic with well-rounded experience. For instance, in the machine shop he will have spent 960 hours on large lathes, 960 hours on small lathes, 480 hours on shaper, 640 hours on planers, 1200 hours on floor work, 320 hours on milling machines and so on. A rigger apprentice's time will be distributed between layout, floorwork, structural work, rigging and erection, riveting and bucking, etc. The other shops are scheduled in a similar manner.

In the machine shop we have a full time job instructor. In smaller shops, where the men work as individuals, the instructing is one of the duties of the general foreman and his assistants. In shops where much field work has to be done, the apprentice may be scheduled as a journeyman's helper; or, if the men work in small gangs, he is assigned to a crew, getting the know-how of the job from other members of the crew and more especially from the foreman of the gang. Our foremen and journeymen are most cooperative in helping the younger men, and rarely have we ever heard of a journeyman refusing to answer the apprentices' questions. At the beginning of the apprenticeship, we caution the boys to be in a receptive mood to any pointers the older men may want to give them, and never to show a know-it-all attitude. The advisability of foreseeing the journeyman's needs and of 100 per cent cooperation is also impressed on the apprentice. We feel this goes a long ways towards interesting the journeymen in our trainees.

We have a wage structure whereby the apprentice's pay increases every 693 hours, the first half of the apprenticeship, and every 1040 hours the last half. This 693 hours is equivalent to 4 months, and 1040 hours is equivalent to 6 months of 40-hour weeks. Overtime shortens and undertime lengthens the 4-month and 6-month periods. In addition to his base rate, the apprentice is paid premium after the first six months of his training is completed. Upon graduation he is promoted into the lower journeyman bracket. So much for our apprentice program.

Another maintenance training activity is a formal 2 year program for selected men in our assigned maintenance department. This is *not* an apprentice program. It is entirely a classroom activity. The personnel for this group is selected from the most promising, previously untrained, young men in the department. Qualifications for admission to this program are also

quite rigid. The men must have a high school education; must possess a high I. Q., good mechanical comprehension and excellent personality. About 35 men are selected. The program starts around the first of September, and runs continuously for 2 years. Classes meet for a full day each week for four sessions per day, two in the morning and two in the afternoon. The class is divided into two groups, one meeting on Wednesday and one on Thursday. The fact that the men have been chosen for this training does not affect their working status, or change their rate of pay in any way whatsoever. They stay right on their existing jobs. There is no rate change schedule, nor any promise of promotion at graduation. However, with the opening of new departments many of our graduates have stepped up into very good positions. Our trainees have also been made to realize that, although no direct promises have been made, the whole training program has been established with the thought of eventually using the group in positions of greater responsibility. The men receive the same wages the day they go to school as they would receive on the job. This includes, not only their base pay, but all premium they might have been paid, any shift differential, or any extra pay which might accrue from an opportunity to float up to a higher paid job.

In the course itself the trainees are educated along both mechanical and electrical lines, the objective of the course being not to wind up with just a millwright or an electrician, but with a combination mechanical-electrical maintenance man capable of taking care of either branch of assigned maintenance work.

The curriculum includes mathematics up to and including elementary algebra and practical trigonometry; blue print reading and field sketching; electrical theory; electrical laboratory; general science and high school physics; mechanics; forces in moving machines; pumps and blowers; hydraulics; lubrication; slide rule; etc. The titles of the courses are fairly self explanatory. However, a few words of explanation might be helpful. Nothing need be said about mathematics. Just enough slide rule is taught to enable them to multiply and divide. In blue print reading, the first few lessons deal with fundamentals. This is followed by practice in transferring dimensions from one view to another, using standard work sheets. Then follow drills in making working sketches from perspective drawings and small objects. Finally comes the study of blue prints of our own equipment, supplemented by sketching detail parts from assembly drawings, and the making out of bills of material.

Figure 2 — Machine shop instructor is on full time.

In our electrical theory class, we cover the fundamentals of electricity and d-c current pretty thoroughly, and touch briefly on a-c current. For a text we have found Nadon & Gelmine's "Industrial Electricity", originally written for the Henry Ford apprentice school, to be one of the best. We have used it in our training program for years. Our electrical laboratory program is designed to teach the group to read wiring diagrams; and, using the same, to study and design circuits and to trace out electrical troubles. The men first are taught the meaning of all the electrical symbols. Then they learn to use these symbols in diagrams of simple circuits, gradually adding contactors and relays until we have a complete control circuit. Then follows work on panels in the laboratory. Here they learn to connect and wire up controls, following wiring diagrams. They also learn to "shoot trouble". Various pieces of equipment from the plant which use different types of controls are analyzed. A projector is also used to show slides of wiring diagrams from which the operation of relays and contactors may be shown and discussed. Each member takes his turn in analyzing various types of controls before the class. Special emphasis is laid on crane hoists, bridges and Ward-Leonard equipment. Laboratory work also includes practice in the use of the ohmmeter, voltmeter, ammeter, wattmeter, tachometer and tong-tester. On-the-job conditions are simulated by panels set up in the laboratory. These have contactors, operating coils, auxiliary contactors and a series of studs each of which is numbered. Wiring diagrams are numbered to correspond. On these panels two or three circuits can be set up in a very few minutes. Changes can be made in the circuits by merely putting jumpers across different studs. A small board is also used for studying the operation of motors. This board has numbered studs with connections leading to a shunt field, series field, and the motor armature. Here again changes can be made in the circuits by merely changing the stud connections. This apparatus can be used to determine if the motor has bucking fields; learn how to correct the polarity of field coils and commutating coils; and how to change direction of motion of all types of motors. Experiments are also conducted in the laboratory which demonstrate the proof of ohm's law; inductance; magnetism; the discharge of a condenser; how to change from a-c to d-c current; etc.

In our physics course the trainees learn about matter; mechanics of gases, liquids and solids; forces; heat; and allied subjects, all of which are elaborated on further in

our mechanics course together with moments of forces, mass, acceleration and kindred topics. This leads into practical applications to machines of such mechanical devices and principles as levers, wedges, inclined planes, gearing, friction, pulleys, cams, screws, etc.

Our hydraulics training includes the study of the fundamental principles of the subject; and also investigations of the hydraulic controls operating our own equipment. Our instructor has made charts of all our controls. These can be used in tracing the operation of each unit and in shooting trouble on the same. For text material we have found the following pamphlets quite helpful: "The Operation and Care of Hydraulic Machinery" by Texaco; "The Fundamentals of Hydromechanics" by Shell Oil Co.; and also pump literature from Vickers, Incorporated, of Detroit. Our instructor, a graduate engineer, was given an intensive four day training course at Vickers preparatory to teaching the subject. Our assigned maintenance program also includes a course in lubrication, prepared and given by our chief lubrication engineer. Subjects covered include "History and Modern Testing Methods of Petroleum Lubricants"; "A.S.T.M. (American Society for Testing Materials) Standard Tests"; "Fitting the Proper Lubricant to the Machine"; "Fluid and Plastic Lubricant Applications", etc. Our own lubrication manual has been written to cover these subjects quite completely. Study of the manual and direct correlation of its text material to company installations form the back-bone of the program.

Lectures on company history and policies, scheduling, costs, safety, economics, etc., are scheduled from time to time. Trips are also arranged occasionally through parts of our own and neighboring plants. Plenty of home-work, quizzes and examinations are given the trainees. By means of these a close check can be kept on the progress of each individual, and recorded. A meeting of training and maintenance supervision is scheduled twice a year. At this time each man's record is gone over carefully. This is followed by personal interviews with each man. Congratulations are extended where merited, or suggestions for improvement are given where needed. On rare occasions, disciplinary action is taken, if such procedure seems necessary.

Up to this point I have discussed our two formal training courses. In addition, we have a short program for training electric crane operators. As the need for operators arises, selections are made from our list of applicants. They are given the same battery of tests as was required for our shops and assigned maintenance trainees. In addition they are given an eye test which requires 20-20 vision and good depth perception. If the candidate passes all entrance tests successfully, then he is entered in an 18-day training program. First the program is outlined to him in detail, and following a lecture on the topics to be studied, he is given written material for home study covering rules of operation, mechanical maintenance and safety responsibilities; charts listing all parts of trolley, bridge, and cab; maintenance of controllers and control panels; inspection of crane; and principles of fire extinguishers. Two booklets entitled "How to Operate a Crane" by the Electric Controller & Manufacturing Co. of Cleveland and "P & H Crane Trouble Shooter" by The Harnischfeger Co. have also been found very satisfactory. The next step after outlining the course to him is to take the trainee to an idle crane where on-the-job instruction is given on: how to safely board a crane, and the location, purpose and operation of all main switches, including the main safety switch on top of the crane, and also the limit switch. For the next few days he is trained on the use of the various controls, singly and collectively. Then follow about 10 days of practice on the use of the controls, emphasizing racking, bridging, hoisting, lowering and proficiency in spotting the crane hook over objects; proper lubrication; inspection; housekeeping; and care of equipment. The trainee is also scheduled for a dope (lubrication) turn with an experienced operator.

A great deal of emphasis is also placed on the necessity of working in harmony with the floor crews, always being certain of their safety and that they are in the clear before making the slightest move. The need of handling equipment and material with a minimum of damage is also stressed.

A distinctive feature of this program is a model crane we have in our training school. It is an exact replica in every way of a standard crane, even to crane columns, runways, railroad tracks, gondola cars, pack lifters, magnets, piles of sheets, etc., all made to an exact one sixteenth scale. The controls for operating this are full sized standard controls. At the close of the training period, the trainee is required to demonstrate on the model to the satisfaction of the instructor that he is familiar with the crane operation.

Then comes a rigid and thorough final written examination covering operating practice, safety regulations and proper maintenance of equipment. The written work is supplemented by oral questions and discussion until the instructor is completely satisfied that the candidate is qualified to become a first class operator.

In the program described up to now, the trainees have all been given their training on company time. However we have many classes conducted on a voluntary basis, that is the men come to school after working hours, entirely on their own time. These classes are not only for maintenance men but for our entire organization. Subjects taught include arithmetic; algebra; geometry and trigonometry; blue print reading; engineering drawing; practical mechanics; first and second

Figure 3 — Assigned maintenance trainees are shown in electrical laboratory.

year electrical theory; electrical laboratory; electronics; general metallurgy; first, second and third year ferrous metallurgy; quality control; study of operations; study of staff departments; etc. None of our maintenance men are entered in our metallurgy or quality control classes, but are well represented in all the others. Many of these maintenance representatives are older men who have not had the opportunity or qualifications to enroll in our formal training programs, but who are anxious to do their utmost to keep abreast of the younger men in the formal programs. Other students include new men in the organization who hope by their efforts to make themselves eligible for consideration for entrance into future formal programs.

The classes usually start about the first of October and run for about 24 weeks of one 2-hour session per week. To get organized and to get the proper personnel for these classes, a training survey is conducted throughout our entire organization each summer. For the survey, conducted by the training department, in the form of interviews with the superintendent of each department, a complete list of his organization is provided him. He is also given a description of each project of the proposed program, and also the past training records of his entire personnel. Future training needs of outstanding employees are discussed and recommendations are made as to each man's needs. The training department contacts each recommended man and makes lists of those interested in each subject. Where the demand warrants, the class is organized. After that text-books must be ordered or in some cases text material must be prepared. Instructors must be obtained for the various subjects, classrooms must be scheduled, etc.

Usually we can get the previous year's instructors to repeat the new program, but occasionally a new man must be found. These men are usually college graduates and company employees. They are always key men in their departments with many years of practical and theoretical knowledge, backed up by teaching experience. So that turn workers may have the opportunity to attend every class, we have repeat sessions of each lesson.

The classroom work includes lectures, class exercises at the desk as well as at the blackboard, quizzes, examinations, and plenty of home study. At the conclusion of the course, records are compiled and placed on the trainee's record in the training and employment department. In addition each superintendent is given reports on what each of his representatives in training has accomplished during the previous year. We feel it is a sacred duty for us to see that each student is given full credit for his training work.

A good many men are taking correspondence courses covering a wide variety of fields. Our door is always open for any of these people needing assistance in their studies. This open-door policy has paid off, for oftentimes men, discouraged to the verge of quitting, have received just the "shot in the arm" they have needed to go on to completion.

A popular correspondence program is a high school course. Many of our men, who have not had the opportunity to attend high school, take this course with the hope of later qualifying for one of our formal training programs. Correspondence courses, we realize, can never take the place of regular school attendance.

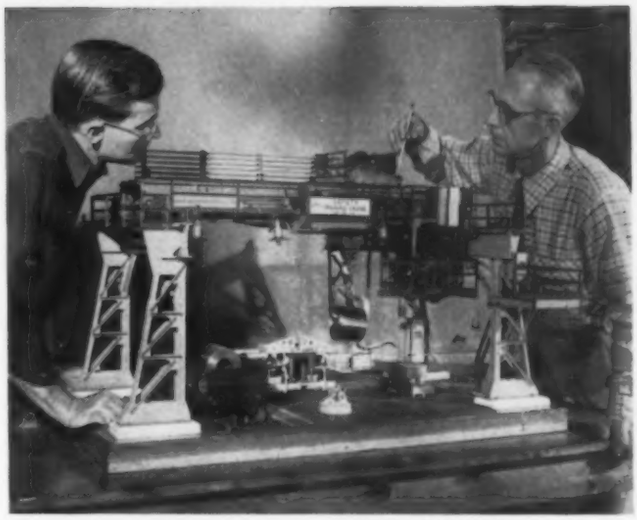

Figure 4 — The model crane is very helpful in the crane operator's course.

However, under guidance, they form a very good next-best substitute. Years ago, correspondence schools were the target of many jibes, but in late years they are being given the recognition they deserve.

So far we have discussed training for the rank and file of our maintenance organization. Our supervision have not been neglected over the years. They have all been through the T.W.I. programs with which no doubt most of you are familiar, namely job instruction, job methods, and job relations training. They have also all been thoroughly drilled in our union contract, and have also had individual coaching from our industrial engineering department on our premium set-up. They have also attended classes in economics, psychology, company policies, conference leadership and many other subjects too numerous to mention.

We are now completing a four hour course for our entire organization known as our "In Our Hands" program. The program consists of movies, lectures and discussions. It is entirely non-political but is designed to spread the gospel of the American way of life and to combat all "isms" (socialism, communism, etc.). We have given this program to 4600 people since November, 1951.

In summation the big question which arises is has it paid to "Train Maintenance Personnel", or any other personnel for that matter? We at Armco feel very definitely that it has. Amongst our company policies are two very definite ones namely, as far as possible to promote from within, and to provide adequate training to make our employees ready for promotion when the opportunity arises. How far we have succeeded over the years can be judged from the fact that our president, Mr. Sebald, started as an office boy with our company. Practically all our top management, all our superintendents, and a vast majority of our other supervision have come up through the ranks.

Getting back to our maintenance department; and, taking our shops for an example, the past ten years has seen 50 per cent of our foremen, 35 per cent of our A journeymen, 35 per cent of our B journeymen, and 56 per cent of our C journeymen developed as the direct result of our training program. Our assigned maintenance and power departments can show similar results.

MODERN MACHINE TOOLS

For the Steel Plant

By W. J. PEARSON
Machine Tool Engineer
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. . . . the ingenuity of the machine tool designer results in high speed automatic production . . . .

▲ MANUFACTURING, as generally carried on in a steel plant, is not the mass production of thousands upon thousands of components such as are encountered in the automotive, radio, household appliance and other industries, but rather the production of numerous items bearing slight resemblance to each other except perhaps in name. It is true that some of the products made run into relatively large lots, such as railroad car wheels and axles, but even with these components, there is a multitude of types and sizes to be dealt with when equipment for their manufacture is considered. This type of production requires that special machine tools be as universal in use as is possible without reverting to the regular machine shop tools, with which all are no doubt familiar.

Basically, any machine in this type of manufacturing depends on every day methods for the removal or shaping of material to obtain the desired product; however, the manner in which either the tool or the work is held or manipulated may, with the addition of attachments either built in or merely added to a standard machine, create an improved tool or method whereby the production is materially increased, quality improved, tool life extended, or any other desired effect attained.

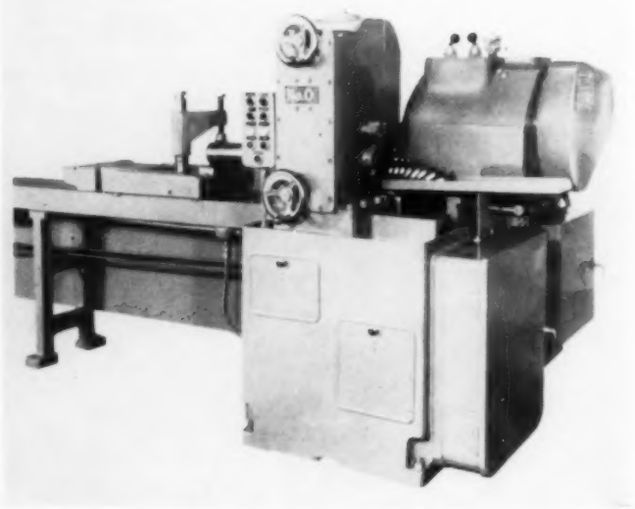
While not all of the standard types of machine shop tools or improvements in same are discussed in this paper, the principles involved in those that are, to a great extent are applicable to any basic tool. It will be apparent that in the machine presented, some bear only a slight resemblance to their prototypes. This lack of similarity in the machine structure is no manner detracts from the action between the tool and the work.

The majority of the work encountered in steel plant manufacturing shops is of a large and bulky nature, requiring considerable idle time of the machine while loading and unloading. Reducing this idle time to a minimum has of course, increased the chip making capacity of the unit, and means to accomplish this objective are noticeable in some of the latest units.

Another element of idle time that has been given a great deal of study in recent years, is the coordination of various movements of either tool or work, and in some cases both, resulting in either automatic or semi-automatic cycles. In some instances where such control has been developed, work that was formerly tedious and difficult to machine accurately is now easier than the simplest operation in the shop.

For many years, improvements in the equipment available for some of the larger lot work were practically of little or no value. The units used were designed for shops particularly interested in finishing or re-machining those components that the steel plant shops roughed out. Special machines were seldom

Figure 1 — Automatic cold saw reduces idle time to a minimum.



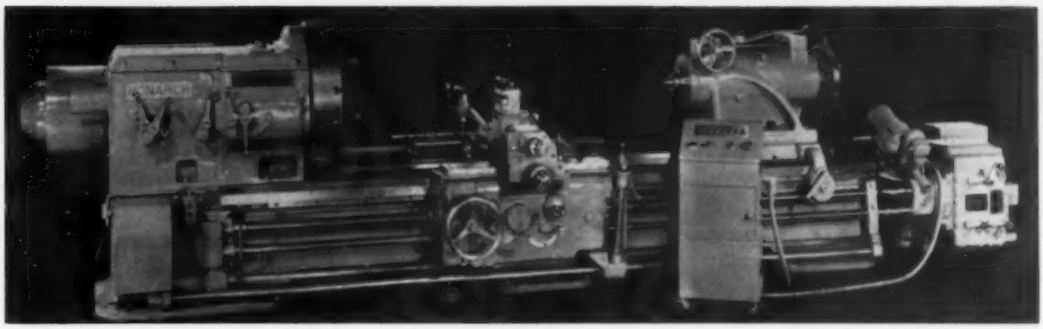


Figure 2 — Use of duplicating equipment gives production practically impossible by manual means.

thought of mainly because of cost, but since the advent of weldments, or combination of weldments and castings, the special machine no longer is a visionary thing. Now it is possible to obtain equipment correct for its specific use, flexible through a limited range and competitive with standard equipment in first cost.

It is with equipment bearing out the foregoing, that this review is concerned.

Everyone at some time or another has used a hand hacksaw to cut off a piece of stock or a nut which has

Figure 3 — A template attachment is used for turning mill rolls.

rusted fast to a bolt. It is safe to assume that after such physical effort, one was glad that the stock was not twice as large or larger. The machine shown in Figure 1 makes easy work of such manual effort and when set for an automatic cycle, produces short ones from ones as long as there is stock available. Each piece is accurate in length and reasonably smooth in finish.

Here in this machine is an example of taking the standard cold-saw, adding an automatically controlled vise, stock stop, bar feed and coming up with a production unit universal within its range, accurate beyond human ability and self-coordinating to keep idle time at its minimum.

Machine shops the world over depend on the engine lathe as much if not more than most other equipment for their ability to produce. One of the oldest tools in existence, it has changed little in its method of operation. By the addition of a follower and coordinating mechanism, a lathe may be made to duplicate from a master form or template with a degree of precision and at a rate of operation practically impossible to obtain by any manual means. Use of the duplicating equipment pictured in Figure 2, detracts in no manner from the normal use of the lathe, if such should be desired.

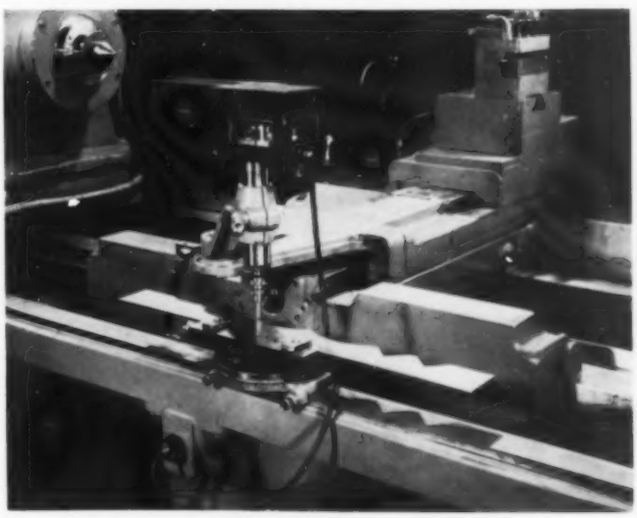
Figure 3 illustrates the use of the duplicating attachment generating the passes in a mill roll from the sheet metal template which appears in the right hand foreground. Figure 4 is a closeup view of the master template and the tracer which coordinates the movements of the carriage and cross-slide causing the tool to cut a reproduction of the template.

The three preceding illustrations have shown what may be accomplished with a standard engine lathe by the addition of an attachment. Figure 5 is an example of what can be done when only the elements of a machine are retained. The unit is designed to machine railroad car axles. No doubt to some, it may be difficult in this view to determine where the lathe begins and ends. In addition to the lathe there is a semi-automatic work loading and unloading device and a chip handling system; little of this latter item appears in the illustration. The lathe is self-controlled, once the cycle has been instigated, in that all of the functions from the gripping of the stock through the movements of the tools in timed relation to each other are actuated by the completion of the preceding movement.

It is evident that this unit has little use other than the purpose for which it was intended, therefore such a combination must present a distinct production advantage over its prototype to justify its existence.

Figure 6 shows the product which is handled by the

Figure 4 — The ratio between the template and the work being cut is about 1 to 1.



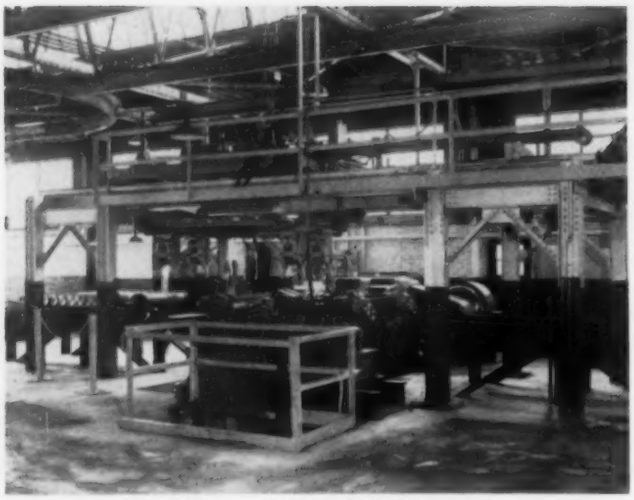


Figure 5 — This unit is a lathe which has been modified to cut railroad axles.

machine. Railroad car axle forgings are rough machined simultaneously on both ends.

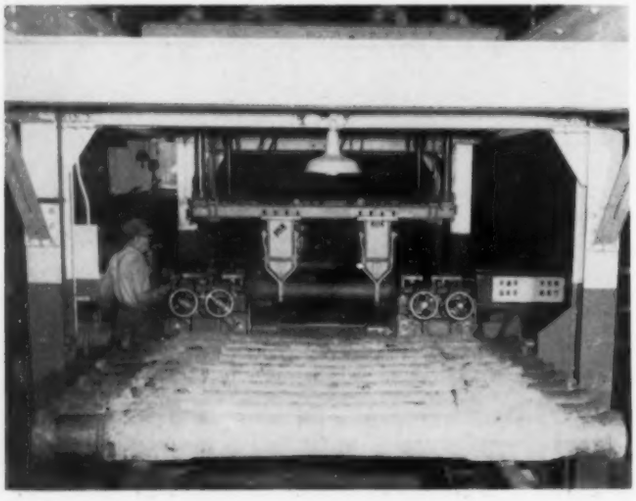
Figure 7 illustrates the machine itself and the work handling device which simultaneously moves a rough forging, previously centered and faced, from the stock skids into the lathe while taking a turned axle out of the machine and leaving it on the delivery skids.

Figure 8 is a closeup of one end of the rough machined axle shown for comparison with the end of an axle machined by former methods. The axle to the rear is the one from the machine in the previous illustrations. While the finish shown is not a direct requirement of this equipment, it indicates the results of the tooling used.

Figure 9 is a horizontal milling machine. In this case the table with the special fixture occupies considerably more space than is customary. Intended primarily for the surfacing of long sections, it does not differ from any other manufacturing type miller, except in length. The product machined in this unit was formerly made by a much more tedious method.

The fixture by its design contributes much to the flexibility of the work range without interfering with the chip making capacity of the unit.

Figure 6 — This axle lathe is a production unit.



Of the many time consuming jobs arising daily in the operation of a shop, probably one of the worst, as well as one requiring extreme skill and patience, is that of die-sinking. No shop engaged in the production of pressed or drop forgings and stamped or drawn work can operate without dies. The skill and effort that goes into the making of a die is returned many times in the

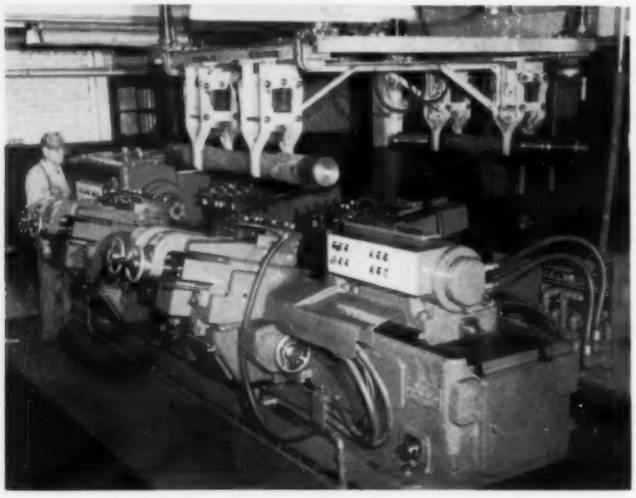


Figure 7 — Work handling devices are an essential feature of this unit.

production of a component made by its use. To simplify the job of producing the intricate profiles required in a solid block of steel, a vertical miller equipped with a duplicator has been employed. See Figure 10. The accuracy with which the work is produced, as well as the finish obtained, result in the elimination to a great extent of the tedious manual work of finishing the machined cavity or profile made necessary when other methods are used.

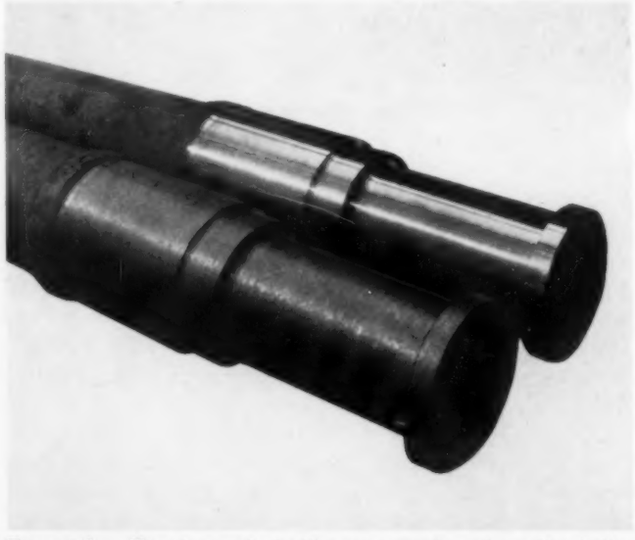


Figure 8 — The top axle is the one produced on the lathe shown in the three previous illustrations.

Similarity between the principles involved in this machine and that employed on the engine lathe previously shown will be noticed. A master template is mounted on the table at the right, which together with the tracer attached to the head carrying the cutting tool, control the relative movements between the cutter and the

Figure 9 — This 28-in. x 216-in. horizontal face milling machine is designed for the surfacing of long sections.

work to produce the desired results. Again, as with the case of the lathe, the duplicating attachment may be disconnected, thus allowing the machine to be used in the conventional manner.

The previous illustrations have shown applications

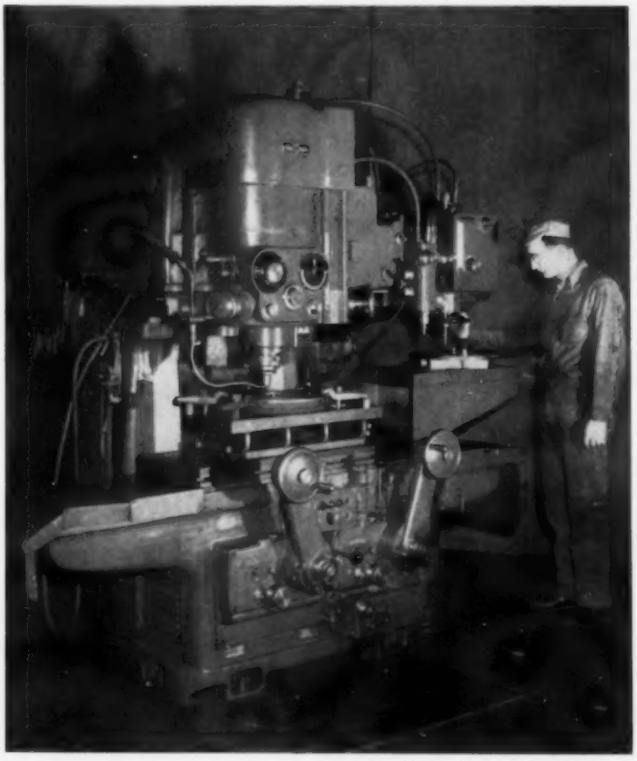


Figure 10 — A vertical miller equipped with a duplicator has been used for making complicated dies in this die-sinking machine.

of duplicating equipment; Figure 11 shows another. In this instance a floor type horizontal boring mill has been adapted to automatic duplicating by the addition of a portable unit to accomplish the desired operations. The previous types shown are more or less permanent attachments, physically tied into the machine, but capable of being rendered inoperative at will. The type used on this machine may be disconnected and removed, with the exception of one or two parts of the equipment, thus leaving the basic tool unhindered in any way for normal service.

The work is at both ends in a special revolving fixture. The pedestal adjacent to the column of the boring mill is equipped with its own drive for rotating the work on its own axis. Geared to the work rotating chuck and revolving with it at a 1:1 ratio is a face plate, whereon the template is mounted. The power unit for the duplicating attachment is located in a convenient position on the floor plate section of the main machine.

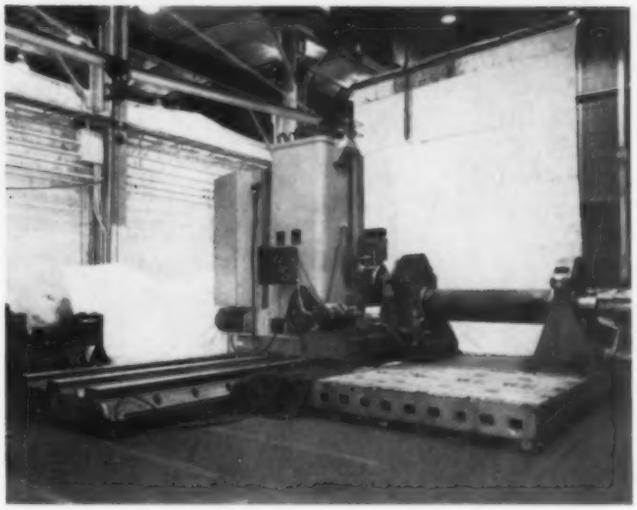
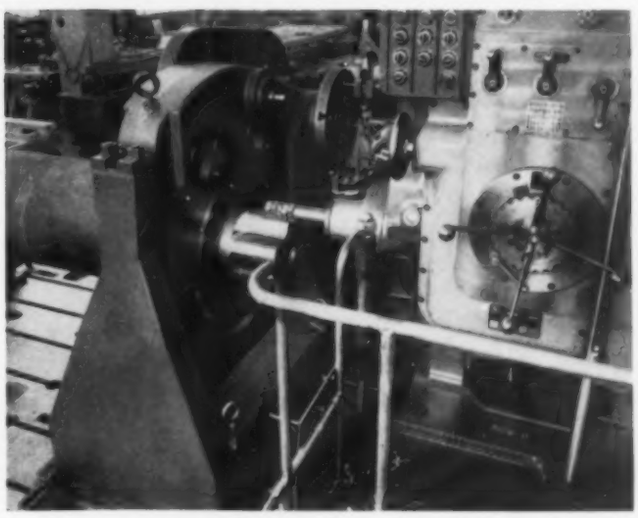


Figure 11 — A portable unit has been added to a floor type horizontal boring mill for automatic duplicating.

Figure 12 shows from the operator's position the template on the rotating faceplate with the follower immediately above. The tool shown in this view was designed primarily for a boring type of cut as illustrated by the longitudinal gash in the work. The cutter has also been used for making a profiling cut, noticeable on the extreme end of the work.

For the final sizing, an interlocking sectional slab mill is used with the machine controls set for profiling. In some instances this type of cutter is used for both roughing and finishing, using the profiling method throughout.

Figure 12 — This close-up view shows the template on the rotating face plate for the boring mill of Figure 11.



Indicative of the last word in accuracy, the jig borer (Figure 13) has come to be known as a type by itself. This type of tool is not particularly new but in late years its use in interchangeable manufacture has increased considerably.

Formerly reserved for the manufacture of jigs and fixtures, from which use its name was derived, operated

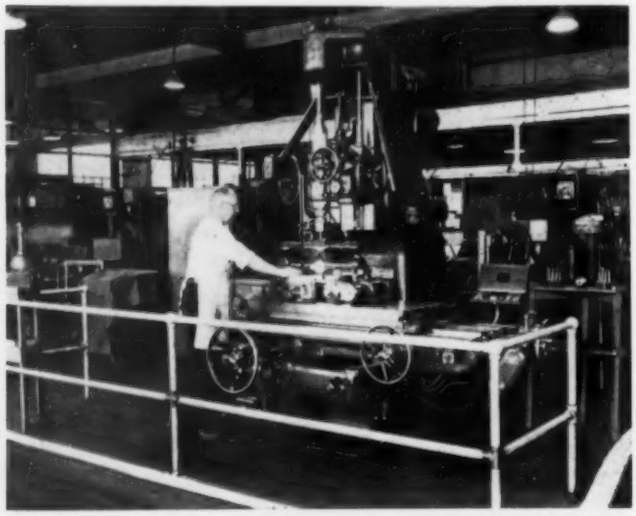
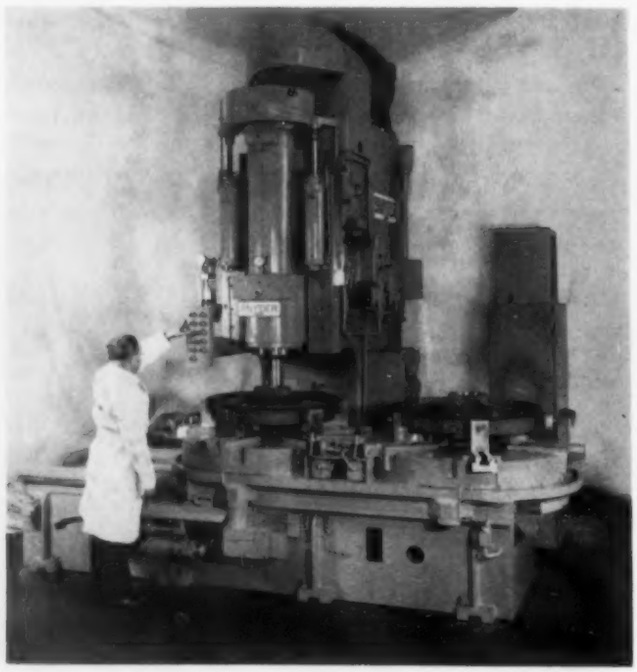


Figure 13 — The jig borer can advantageously be used for some types of production machining.

by patriarchs of the tool room, it was a tool considered by many too delicate and expensive a machine for regular shop use.

When used for the production of short run work, it often saves the expense of elaborate and costly fixtures, for if properly equipped with accessories, pieces may be completely finished in one setting. Such operations as drilling, milling, boring, counterboring and the like, involving compound angles with accurate spacing

Figure 14 — Unit shown was designed specifically for boring wheels.



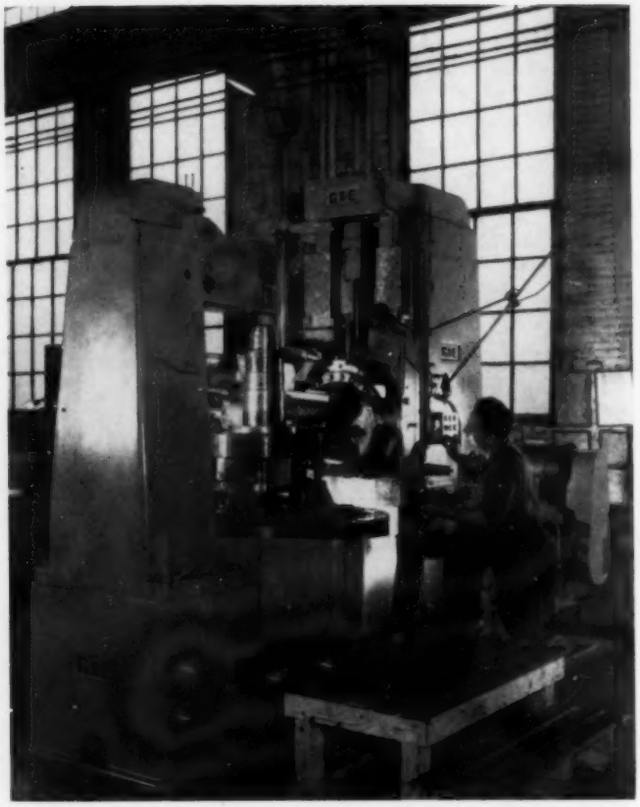


Figure 15 — The universal hobbing machine is normally used for small or medium quantity production of gears.

located by rectangular or polar coordinates, are all easily accomplished.

Illustrative of a machine designed specifically for one class of work, this wheel borer (Figure 14) goes quite a ways from its predecessor, the lowly drill press. For the production rough boring of car wheels and

Figure 16 — Hobbing machine shown is used for cutting worm gears.

other similar circular products, having in most cases a hot-punched hole, it is a good example of the manner in which idle time has been reduced to a minimum. When equipped with work loading and unloading facilities at each end of the table the idle time is reduced

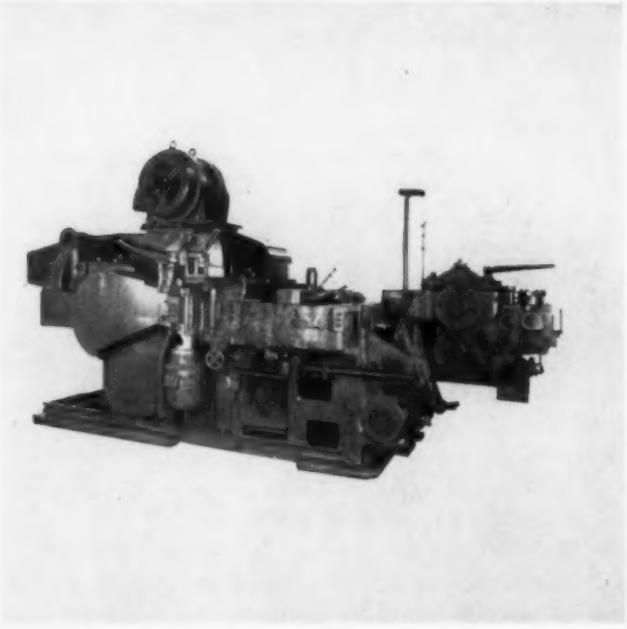


Figure 17 — Machine shown cold forms bolts in six operations.

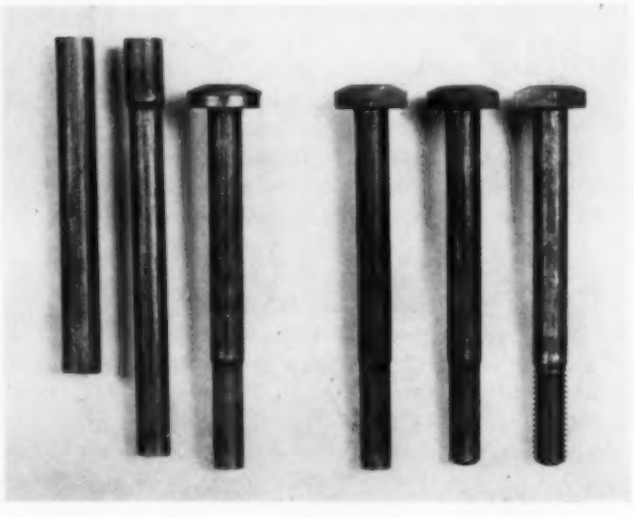
to the interval for withdrawing the boring bar and the indexing of the work chucks from left to right or vice-versa. Chips are deflected by proper tool design downward through the hollow chuck and on through the bed to a conveyor and thence to adequate containers.

To operate efficiently such a machine incorporates a simple powerful drive to the rotating tool, massive frame and bed members to absorb the varying tool pressures caused by non-uniform stock distribution and semi-automatic sequence control.

All of the refinements in modern machine design are utilized in its construction such as hardened and ground ways with independent automatic lubrication, separate hydraulic systems for tool feed as well as chucking and indexing the work, electrical interlocking of the various movements to provide maximum safety to the operator and variable spindle speeds through control of the main drive motor.

No paper on machine shop tools would be complete without some mention of the equipment utilized to produce the gears required in our tools, automobiles, turbine drives and other necessities or luxuries too numerous to mention.

Figure 18 — Six steps in producing a bolt are illustrated here.



While Figure 15 shows a universal hobbing machine, generally used for small or medium quantity production, the principle on which this unit operates is identical to that in the equipment used for making either gears for watches or cameras or transmission gears for automobiles. Other methods are of course available for producing gears, however, the hobbing method is probably used most extensively for spur, helical and grooved herringbone gear manufacture.

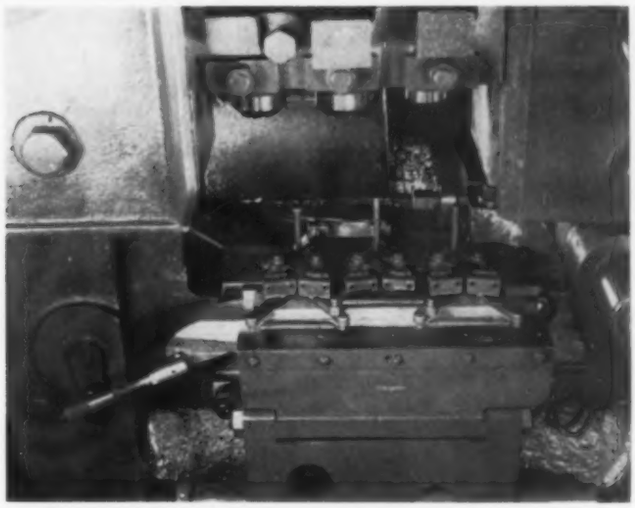


Figure 19 — Illustrations show the first three steps in the production of the bolt going from right to left.

Outwardly the unit in Figure 16 bears little resemblance to the preceding one. It is nevertheless a hobbing machine, but designed for the production of worm gears only.

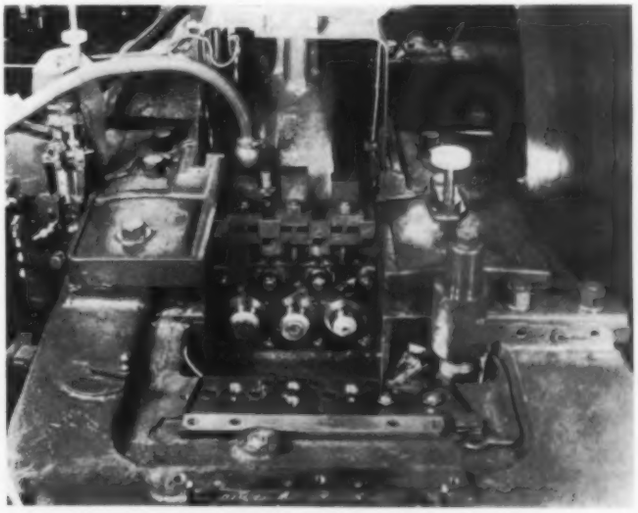


Figure 20 — After leaving the trimming die, the bolt goes up the bent tube.

As most large worm gears are seldom produced in quantities sufficiently large to justify the expense of special hobs, the tool frequently used is of the fly-cutter type.

Without getting involved in the pros and cons of

worm gears, it may be said that this machine is arranged for either feeding the cutter tangentially to the work, or if desired, radially.

Not ordinarily found in the average machine shop, except perhaps for repairs, the machine shown in Figure 17 is by the latest definition of the term of "Machine Tool" just that, for it makes a product by the shaping of metal primarily without any chips. This machine, called a cold bolt maker, takes a coil of rod and in six operations produces a complete bolt.

Figure 18 shows the six phases in the making of a square head, rolled thread bolt. From left to right the blank stock is sheared from the coil after being straightened while entering the machine; next the body is extruded to give the proper body diameter; then the portion to be threaded is further extruded to approximately the pitch diameter of the thread while the opposite end of the blank is upset and crowned for the head; the head is then trimmed to the proper square size; next the thread end is pointed, and last but not least the thread is rolled to complete the bolt. The views of the different stages of production are shown in their relative position to the blank giving an idea of how the piece progresses through the machine.

Looking down into the die pocket of the machine (Figure 19), one may see the bolt in the first three stages of completion as the pieces are being moved by the transfer fingers to the next successive operation. The piece on the left will be held in the pocket toward the front of the machine when the trimming die on the ram advances over the head, thus trimming it to a square.

The bolt passes through the trimming die and on up the bent tube shown in the upper left of Figure 20. Each succeeding bolt, when trimmed, pushes its predecessor along till they lay in the chute (barely visible on the extreme left) feeding the rotating pointer. From the pointer the piece is transferred to the chute feeding the threading dies (visible at the extreme top).

From the chute the blank bolt is fed into position where the moving die engages and carries it through the thread rolling operation. Now complete, it falls down the discharge trough into a container, too hot to handle though made by a cold process.

The ability of a machine, whether it be standard or special, to produce more chips per unit of time soon reaches a point beyond which it becomes increasingly hard to progress. Unfortunately, chip making time is only a small percentage of the whole and has been made smaller by developments as have been illustrated. At present, in the type of manufacturing with which this paper is concerned, a balance between machine and tool (work permitting), has generally been reached. Much credit is due to those whose ingenuity has brought about this situation. We are now confronted with a challenge: "What is the next step in this game called production?"

DISCUSSION

PRESENTED BY

W. H. WILLIAMS, Superintendent of Rolls, W. Ames & Co., Jersey City, N. J.

A. J. FISHER, General Manager, Bethlehem Steel Co., Johnstown, Pa.

H. J. LeBECK, Joseph T. Ryerson & Son, Philadelphia, Pa.

C. S. CASSELS, Plant Engineer, Henry Disston and Sons, Inc., Philadelphia, Pa.

W. J. PEARSON, Machine Tool Engineer, Engineering and Construction Dept., Bethlehem Steel Co., Bethlehem, Pa.

W. H. Williams: On contour turning of rolls, what sizes do you go to? Do you go as low as a 10-in. diam on contour?

A. J. Fisher: In the first figure, what kinds of cutters are being used in cutting the bar up in small slices?

H. J. LeBeck: In profile cutting, could you have a proportion between cutting tool and pilot or finger? In other words, where large areas are to be machined, could smaller templates be used, or do you have to have a 1:1 ratio between cutter and template?

C. S. Cassels: What is the size of the smallest radius or fillet that can be turned by the tracer equipped lathe when on roll work?

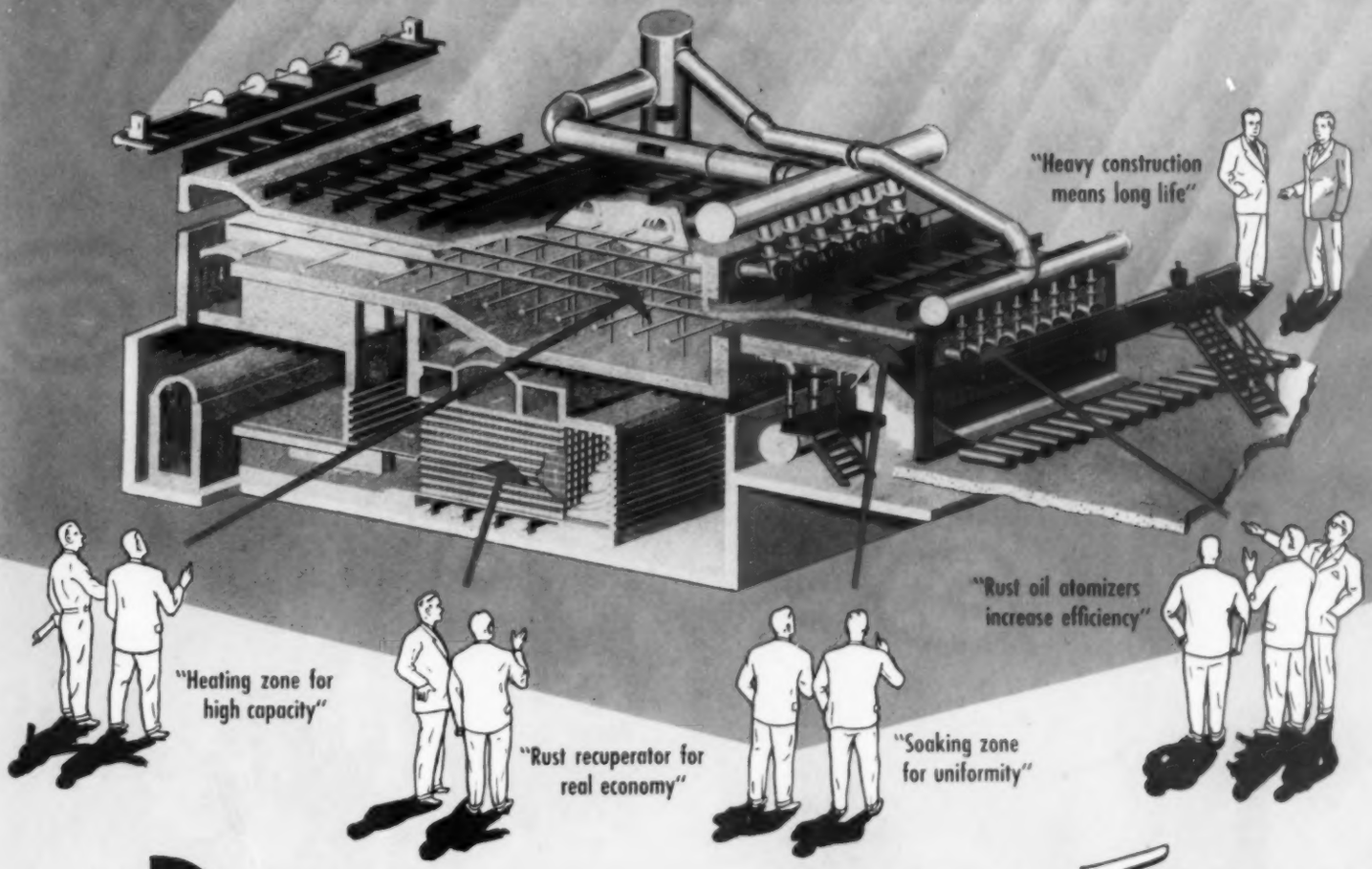
W. J. Pearson: On the question regarding the size of the roll, there is no limit as far as I have been able to determine, unless the work is so small it will not stand any tool pressure. The type machine shown, while not on a roll, has turned material down to $\frac{1}{16}$-in. in diam. I do not know of any rolls that would be that small, but the same type of duplicator and machine can turn work in that range.

Mr. Fisher wants to know what kind of cutter we use on the cold saw. On the machine illustrated, the saw or cutter is what is known as a segmental type blade with the tooth section made of high speed steel.

The next question was on the relationship of the size of template to the work produced. I do not know of any commercial application wherein the template is anything but 1:1. There is the actual size of the tracer to be taken into account. In other words, there is a certain movement to the tracer before there is any movement to the tool and the template must be altered by that amount, which is of the order of a few thousandths of an in. That is only necessary when the character of the work demands that such accuracy be obtained.

On the question as to the minimum radius that can be turned, the equipment itself has no limit. The governing factor, as we have found out, happens to be the size of the tool you can keep a tip on. We have generally limited our tool size, speaking of one particular plant use, to $\frac{1}{16}$-in. radius. If the size of groove is meant, you can make it as small as you can get a tool to stand up in service.

FURNACE MEN KNOW THEY'RE BETTER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1 *Protect against short-circuits.

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4 Provide thermal protection — for panels and switches against damage from heating due to poor contact.

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"We carefully checked the load and found that it was unbalanced but that 600 ampere fuses were the size that should be used.

"The load was balanced and to be sure poor contact was eliminated, the clips in the switch were replaced. Then FUSETRON dual-element Fuses in 600 ampere size were installed.

"Since then Russell Creamery Co. has not had to call us once to replace a main fuse.

"Later Russell Creamery built an addition to their plant. We got the job. It was still not necessary to change the 600 ampere service.

"They seem very pleased with our work and we give a good deal of the credit to Fusetron Fuses."

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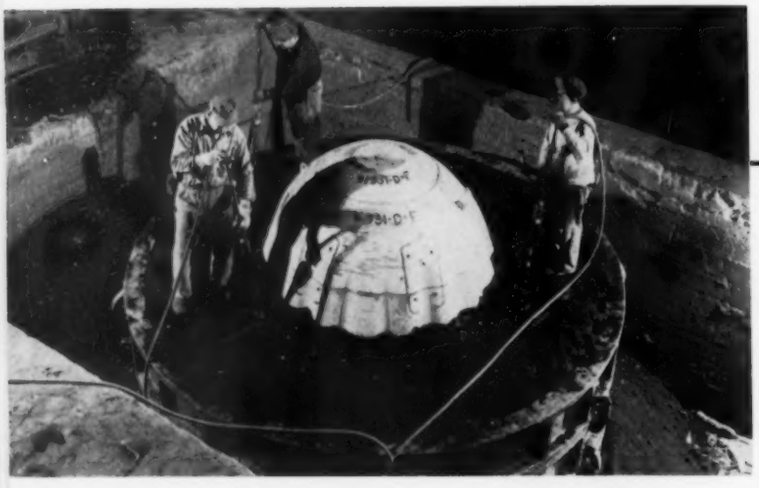
BETTER DESIGN INCREASES

1 — Dimensions of a new wooden pattern for the Johnston corrugated cinder pot are checked in the pattern shop at the Midland, Pa., plant of Mackintosh-Hemphill Co. before it goes to the foundry. Patterns range up to 10 ft in height with rim diameters up to 11 ft. A 500-cu ft oval cinder pot is 15 ft long and 10 ft wide at the top. Wall thickness varies with pot size, users' specifications, and/or needs.

2 — After setting the pattern in a casting pit over a core arbor in the drag flask (cast retaining ring), air rammers pack the mold sand to form the core. The core arbor is a perforated hollow cast steel cone which is filled with coke and serves as a vent for the core.



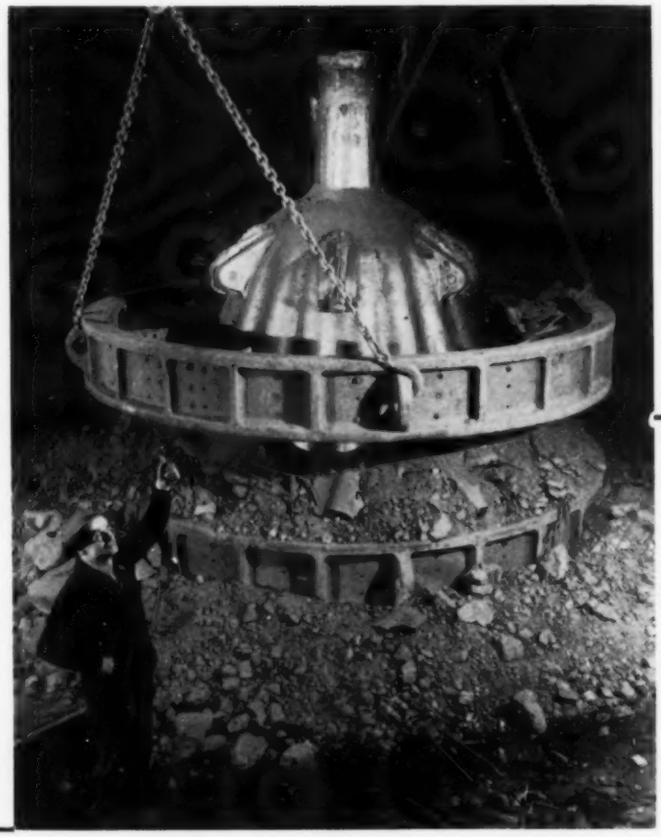
3 — A silica facing sand covers all pattern surfaces, inside and outside. Flasks are added as rammed sand is built up around the pattern in the cope half of the mold. Flasks of smaller diameter will be used above this level.

4 — After the pattern has been completely rammed, the cope half of the mold is lifted off and the pattern removed from the drag half of the mold. The core is smoothed over and given a silica wash. It is then put in a drying oven for 36 hours after which it is ready for the casting pit. After it cools it is given another silica wash. It is then ready for assembly with the cope half. Finishing operations on the cope half of the mold are much the same as on the core.

5 — Molten steel is poured from a ladle into the gated mold. The stream of molten steel divides in opposite directions in the wall near the bottom of the mold. Pouring takes only two to three minutes. A 4-in. hole in the bottom of the ladle is opened by a lever mechanism which lifts a stopper on a rod extending up through a fireclay sleeve over the top of the ladle. After the metal has started up the riser over the dome, additional metal is poured into the riser to feed the casting as the metal shrinks during cooling. It takes 10,000 to 50,000 lb of steel to make Johnston cinder pots having capacities up to 500 cu ft of slag.

CINDER POT LIFE

7 — The riser is burned off by an acetylene torch. A large riser is desirable to supply molten metal to the cooling casting. Gates have already been burned off and are laying at lower left. The remaining stub of the riser is ground off to the contour of the pot by powered hand grinding wheels. Cinder pots are then annealed for stress relief, the operation taking about one week.



◀

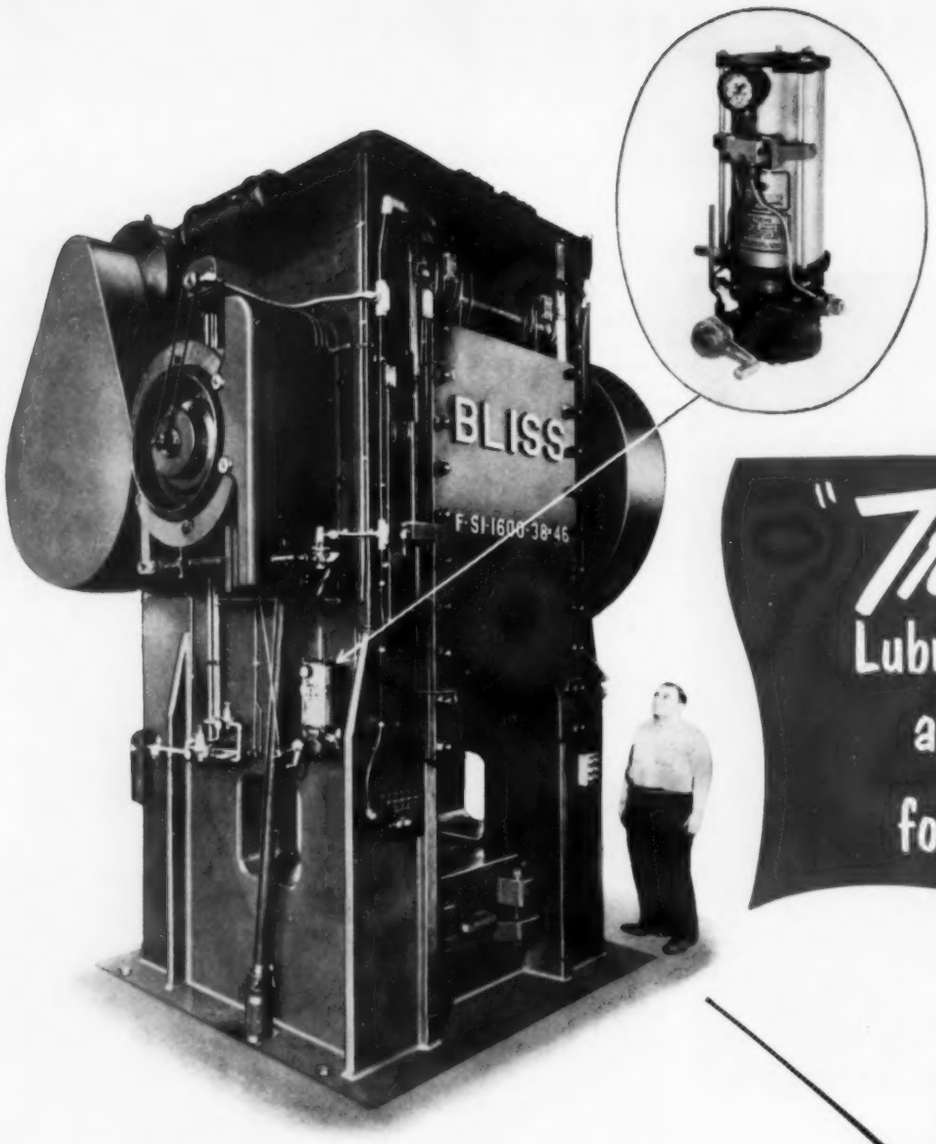
6 — Flasks are removed from cinder pot castings on the shake-out floor after they have cooled sufficiently, usually in 24 hours after pouring. The castings are rough cleaned with pneumatic chisels.

▶

9 — Johnston cinder pot rims are band sawed at the centers of corrugation openings to permit thermal expansion and contraction without permanent distortion. This permits return to true circular or oval shape. Rims have been used on Johnston cinder pots since 1941. However, Mackintosh-Hemphill Co. continues to make some rimless cinder pots.

8 — After the surface is prepared by grinding, a copper coating is applied on the bottom of most cinder pots by metallizing. This minimizes sticking of material in the pot. Copperizing was introduced in 1940 and is now widely specified. Pure copper wire is melted by oxy-acetylene flame as it is fed into the gun by an air driven motor. Escaping air also blasts the metal particles through the flame onto the wall of the pot.

10 — After careful inspection, the pots are shipped to users, where they are mounted on special cars. Blast furnace slag at about 2930 F flows into the pot where it quickly loses a large amount of heat through the walls and the temperature drops to a safe level.



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OIL AND GREASE SYSTEMS

Date-line Diary...

August 1

▲ The Weirton Steel Co. and Independent Steelworkers Union met today to ratify wage agreement. A 25¢ wage increase is retroactive to March 1.

August 2

▲ Government ordered steel producers to set aside 20 per cent of their monthly output for military and atomic purposes starting October 1.

▲ Commerce Department reports that construction expenditures in July climbed to $3,100,000,000 or 3 per cent above June.

August 3

▲ The Acme Steel Co. declared their 293rd consecutive dividend. Because of the strike this was reduced to 40¢ from the usual 50¢ per share. Net sales for the six months ending June 30, 1952 were $27,587,840. Net income after taxes totaled $1,609,975 or 81¢ per share.

August 4

▲ Inland Steel Co. and the CIO Steelworkers signed a formal contract. The Wheeling Steel Corp. and the CIO Steelworkers also signed their formal contract today.

▲ AISI reports that steel production beginning Monday, August 4, is scheduled at 83.6 per cent of capacity. This is equivalent to 1,737,000 tons of ingots compared with last week's actual output of 891,000 tons (42.9 per cent capacity).

August 5

▲ John L. Lewis notified the anthracite operators that he was giving them a sixty-day notice for termination of the present contract.

▲ Employment in the United States declined to 62,234,000 in the month ending July 12 according to the Commerce Department. This is a drop of 350,000 from the preceding month.

▲ The Aluminum Association reports that June production of primary aluminum amounted to 154,952,241 lb, a 14½ per cent increase over the same period last year. Shipments of aluminum sheet and plate for June were 87,585,828 lb compared with 85,400,645 lb in May.

▲ Shipments of iron ore in July dropped sharply as a result of strikes totaling 1,903,672 tons compared with 13,574,271 tons in July 1951.

August 6

▲ At Gulf Coast ports Bunker C Fuel oil was reduced 25¢ a bbl, 35¢ in New York and 36¢ in Boston by Esso Standard Oil Co.

▲ Lukens Steel Co. and the CIO Steelworkers voted to end its strike under an interim agreement.

▲ The Federal Statistical Bureau reported July production of steel in the Ruhr at 1,337,000 tons, which is the highest since the war's end. Pig iron is being produced at a record rate of 13,000,000 tons annually.

August 7

▲ Net income for class 1 railroads for the first six months of 1952 was $290,000,000 compared with $260,000,000 for the same period in 1951 according to the AAR.

▲ In East St. Louis the price of zinc was reduced to 13½¢ a lb, a drop of 1½¢.

▲ Columbia-Geneva Steel Division of United States Steel will operate a large tank castings plant at Pittsburg, Calif. The Army expects to spend $9,500,000 to rebuild this plant.

▲ U. S. Steel Corp. started rail shipments of iron ore at a rate of approximately 600,000 tons a month. Rail shipments cost $1.50 a ton more than Lake-rail deliveries.

August 8

▲ Personal income in June climbed to an annual rate of $266,000,000,000, up $1,500,000,000 from May. Of this, wages and salaries in private industry totaled $146,000,000,000.

▲ Bethlehem Steel Co. and CIO completed a contract settling all strike issues.

August 11

▲ The AISI reports steel production for the week beginning August 11 is scheduled at 95.4 per cent of capacity. This is equivalent to 1,981,000 tons of steel. Actual production for the week ending July 26 was 317,000 tons or 15.3 per cent of capacity. Actual production for the week ending August 2nd was 891,000 tons or 42.9 per cent of capacity. Actual production for the week ending August 9 was 1,866,000 tons or 89.8 per cent of capacity. About 18,000,000 tons of steel has been lost in April, May, June, July and August as a result of the strike.

August 12

▲ According to the ARCI, July deliveries of freight cars totaled 5402. Orders totaled 1536 leaving a backlog on August 1 of 95,265.

▲ Price of zinc advanced ½¢ to 14¢ lb in East St. Louis.

August 13

▲ Continental Steel Co. reduced the quarterly common dividend to 35¢ from the regular 50¢.

August 14

▲ Canadian dollar rose to $1.0434 in New York, the highest point in eighteen years.

August 15

▲ Pittsburgh Steel Co. signed a complete written contract with the CIO Steelworkers.

▲ United Engineering and Foundry Co. reports net income of $1,933,587 or 77¢ per share compared with 77¢ per share for the same period in 1951. Net sales totaled $42,544,934 compared with $29,363,816 for the same period the previous year.

August 16

▲ Streamlined procedures for acting on wage settlements have been adopted by the Wage Stabilization Board in line with the basic steel agreement, the board stated it would approve settlements based on the steel agreement for companies which have followed the steel wage pattern.

▲ Jones & Laughlin Steel Corp. and the CIO Steelworkers completed a wage contract.

▲ Defense Production Administration reports the New England Steel Development Co.'s certificate of necessity to build steelmaking facilities in the area have expired, and will not be renewed.

August 18

▲ Allegheny Ludlum Steel Corp. and the CIO Steelworkers concluded an agreement.

▲ An agreement has been reached between the Aluminum Co. of America and the CIO United Auto Workers on a new contract covering 4000 hourly workers at four Alcoa plants. A straight 10 per cent increase for hourly rates for job classification within the bargaining unit is retroactive to March 10, 1952, which will average approximately 16¢ per hr. A further 4¢ an hr wage increase will be effective July 1, 1952. The company has agreed to a union

security provision identical with the one adopted by the CIO Steelworkers.

▲ Based on reports of companies having 93 per cent capacity for the steel industry the operating rate is scheduled at 97.2 per cent of capacity for the week beginning August 18. This is equivalent to 2,019,000 tons of steel ingots and castings compared with actual production of 1,938,000 tons one week ago, when the operating rate was 93.3 per cent of capacity.

▲ Acme Steel Co. and the CIO Steelworkers signed an interim agreement for a wage increase averaging 16¢ an hr.

▲ Commerce Department reports that the gross national production rose to an annual rate of $342,000,000,000.

▲ Jones & Laughlin Steel Corp. reported sales for the first six months of 1952 of $229,240,000. Net income totaled $4,601,000 or 62¢ a share compared with $2.42 a share in 1951.

August 19

▲ New price increases for steel were established which are retroactive to July 26, 1952. The OPS issued a formal order granting ceiling price increases averaging $5.20 a ton for carbon steel products, and similar increases for alloy and stainless steels.

▲ Orders for equipment, supplies, construction and expanded production facilities totaling $44,900,000,000 during the fiscal year ending June 30 have been placed by the Defense Department. $38,000,000,000 of these orders were for planes, ships, guns, ammunition and tanks.

August 20

▲ President Truman now predicts the Government's deficit for 1952-53 will be $10,300,000,000, which is $4,100,000,000 less than he predicted in January.

▲ Commerce Department reports United States business firms had $14,900,000,000 invested in plants and facilities abroad at the close of 1951.

▲ For the week ending August 16 iron ore shipments from the upper lakes region reached the highest weekly record in history with 3,280,094 gr tons compared with 3,186,811 for the preceding week.

▲ Crucible Steel Co. of America announced net income after taxes for the second quarter totaled $408,605, or $0.05 per share of common stock outstanding at June 30, 1952, as compared with $3.34 per share for the second quarter of 1951.

▲ F. W. Dodge Corp. announced that in July in the thirty-seven states east of the Rockies, construction contracts awarded were $1,511,285,000, or 10 per cent ahead of the same period in 1951.

August 21

▲ The President's mobilization advisory committee has approved a pricing formula that will permit manufacturers using steel, copper and aluminum to pass along recent increases in prices of these metals.

▲ Republic Steel Corp.'s Canton and Massillon plants are producing titanium and titanium alloys. However, production is limited and under strict allocation by the Government.

▲ Allegheny Ludlum Steel Corp. announced net earnings of $889,425, for the second quarter of 1952, or 49¢ a share of common stock after preferred dividends. Sales for that quarter totaled $36,510,238.

August 22

▲ The British Steel Industry under state ownership, the National Iron & Steel Corp., reported a profit of $96,590,065 during its first 7½ months. Total output for steel in 1951 was 15,638,000 tons, or 4 per cent less than the record 1950 production.

▲ The Youngstown Sheet & Tube Co. reports net profit for the first six months of 1952 of $8,504,618, or $2.54 per share compared with $16,354,744 or $4.88 per share for the same period of 1951.

August 23

▲ Inland Steel Co.'s No. 2 Blast Furnace at its Indiana Harbor Works will be operated to produce 800 tons of pig iron daily for U. S. Steel's Gary Works.

August 25

▲ Alcoa announced that it plans a $400,000,000 aluminum smelting plant near Skagway, Alaska.

▲ The AISI reports that the operating rate of the steel industry is scheduled at 98.7 per cent of capacity for the week beginning August 25. This is equivalent to 2,050,000 tons of steel ingots and castings compared with actual production of 2,017,000 tons one week ago when the operating rate was 97.1 per cent of capacity.

August 26

▲ Under an employee ownership plan, Inland Steel Co. announced it is offering company stock to eligible employees equal in value to 25 per cent of their 1951 earnings at $42.25 a share.

▲ United States Steel Corp. announced earnings for the second quarter of 1952 amounted to $22,218,922 or 61¢ a share on common stock. Results for second quarter was actually a loss of $20,800,000, but a tax credit of $43,000,000 offset this loss. Earnings for the first six months were $65,753,134, $2.04 a share, before dividends on total sales of $1,460,948,192.

▲ According to the American Institute of Steel Construction, July bookings of fabricated structural steel amounted to 221,389 tons, or a 32 per cent increase over June. Shipments during July were 135,860 tons, 8 per cent greater than June, but below the 204,380 tons of July 1951. Backlog as of July 31 stands at 2,361,027 tons.

August 27

▲ The National Production Authority pledged to builders that construction curbs will be "substantially relaxed" before April 1, 1953.

▲ Iron ore shipments down the Great Lakes reached near record shipments for the week ending August 25, totaling 3,247,327 tons, slightly below the record high of 3,280,094 for the previous week.

August 28

▲ President Phil Murray of the United Steelworkers of America and Congress of Industrial Organizations received a raise of $15,000 a year, boosting his salary to $40,000.

August 29

▲ The Commerce Department reported manufacturers' inventories have fallen $900,000,000 from the record high at the end of March. On July 31 seasonally adjusted inventories amounted to $42,000,000,000, which was $2,200,000,000 higher than one year ago. In July manufacturers' sales were $21,500,000,000.

▲ The DPA has asked for 117,000,000 kw of electric power generating capacity by December 31, 1956, which would be an increase of 42,000,000 kw above nation's generating capacity at the end of 1951.

August 30

▲ A $4,000,000 electric furnace is being planned by Vancouver Steel, Ltd. near an iron ore deposit on Vancouver Islands, B. C.

▲ President Truman announced oil import duties will be cut as much as 50 per cent, under an agreement with Venezuela, in return for extensive tariff concessions on American exports to Venezuela. This will apply to petroleum shipments from all countries with which the United States has reciprocal trade pacts.

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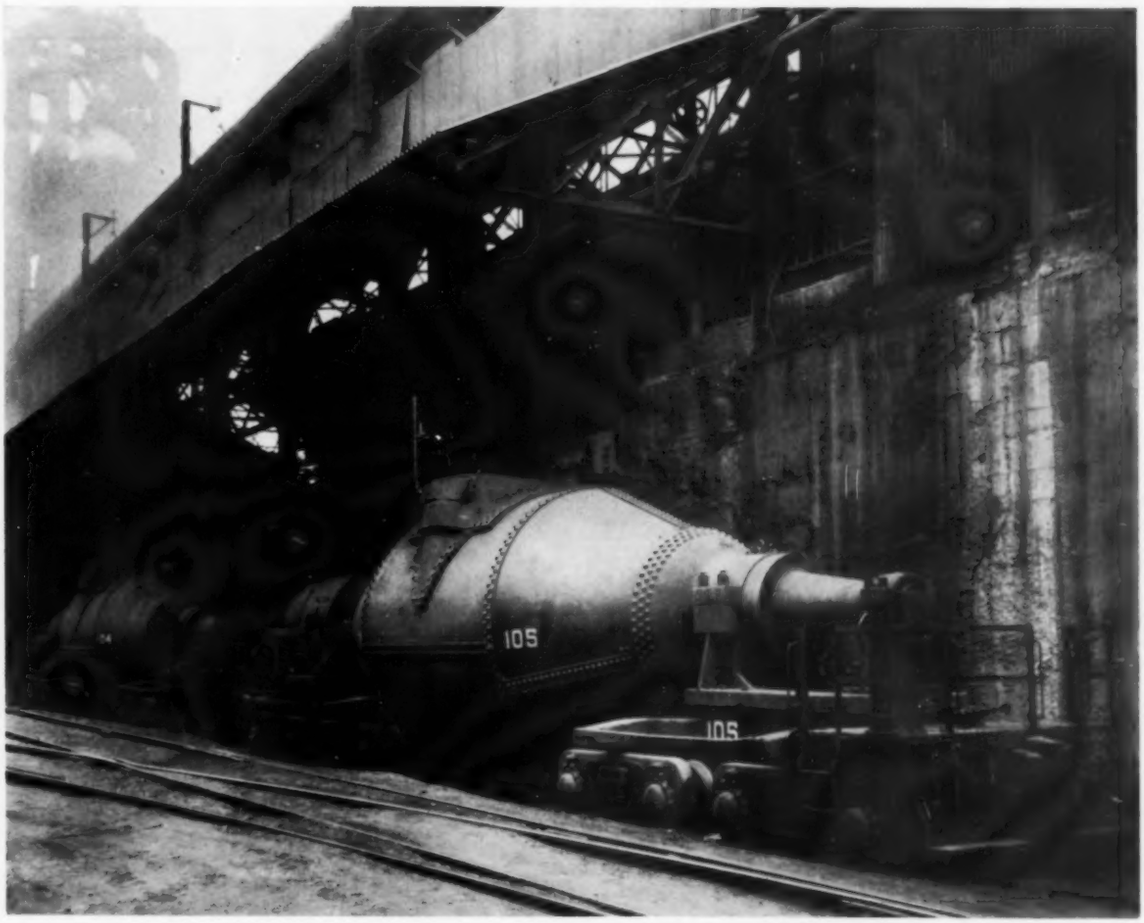

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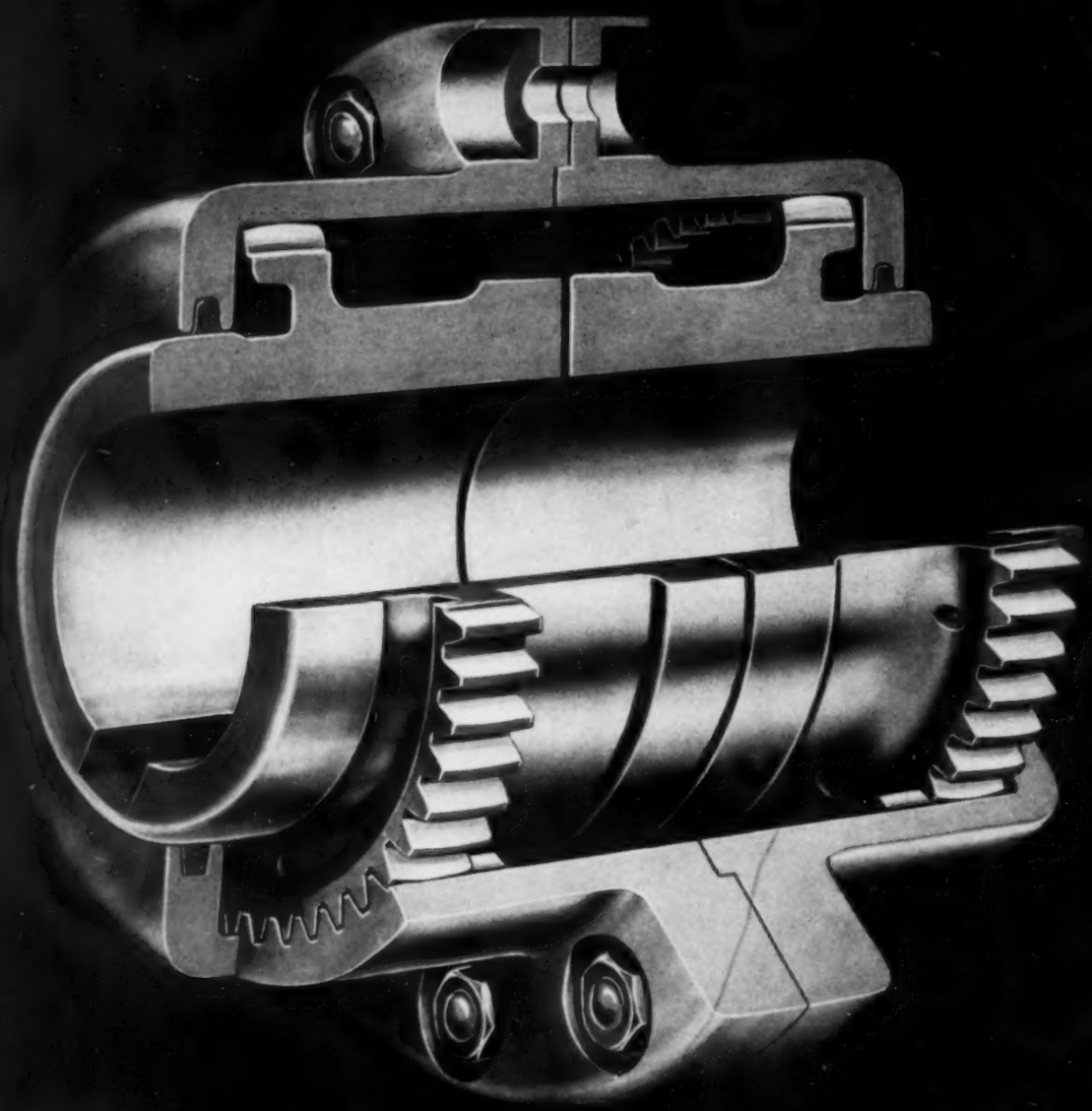

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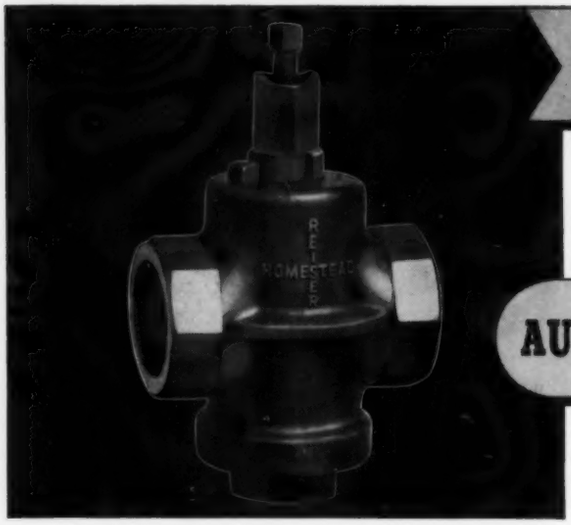

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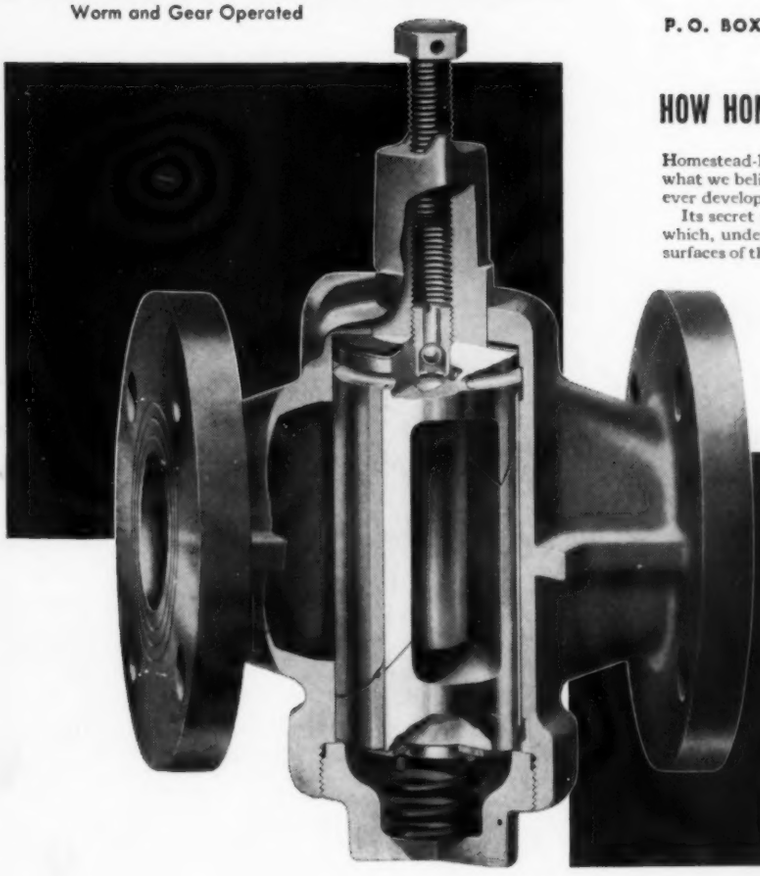

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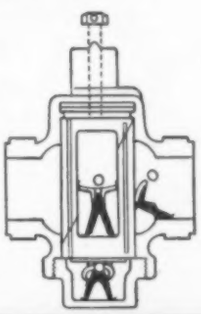

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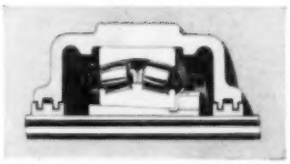

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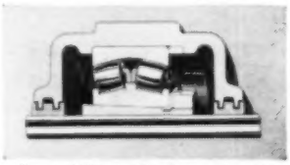

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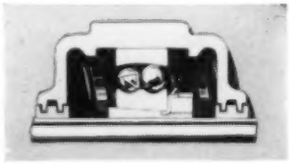

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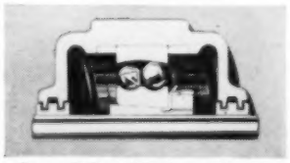

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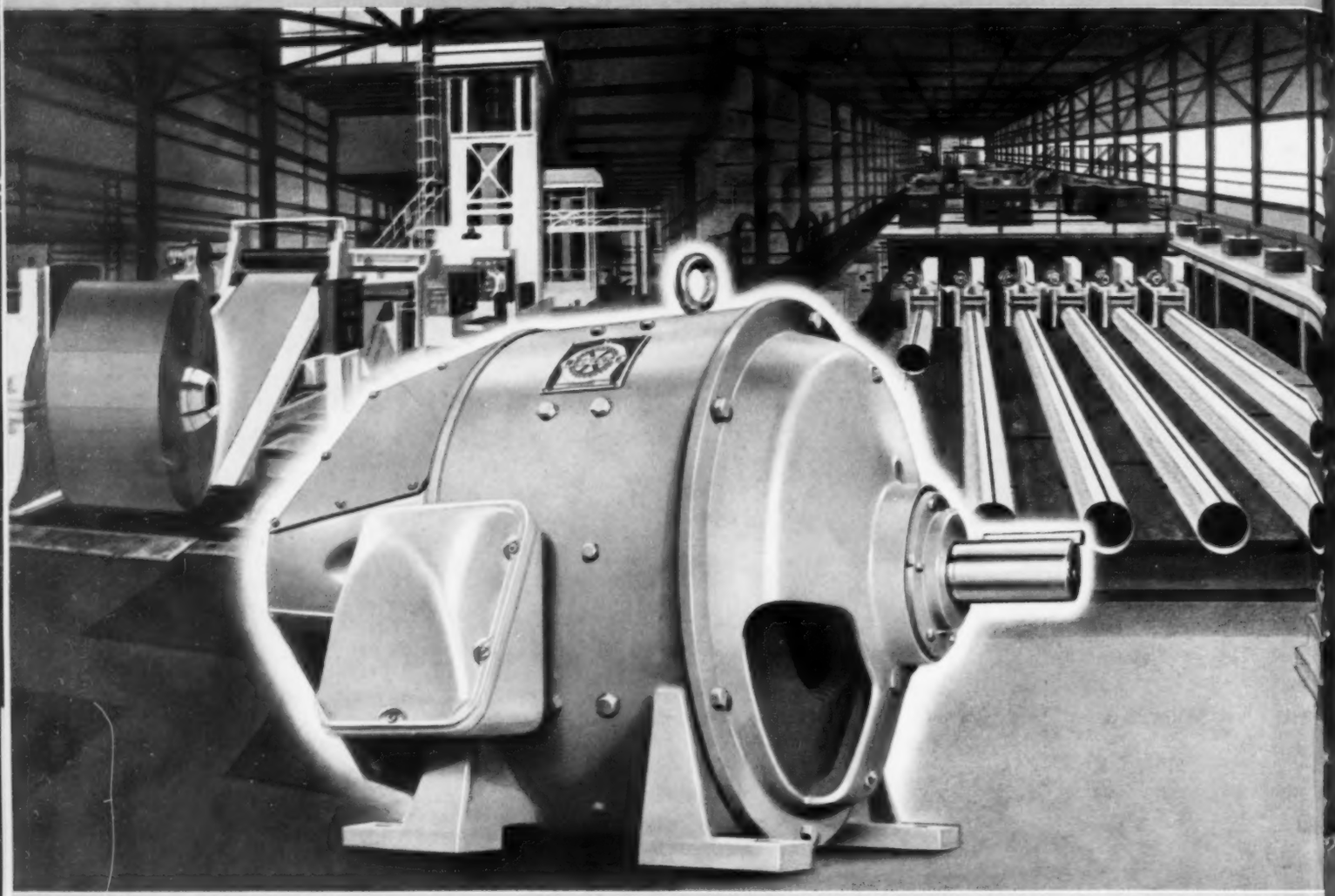

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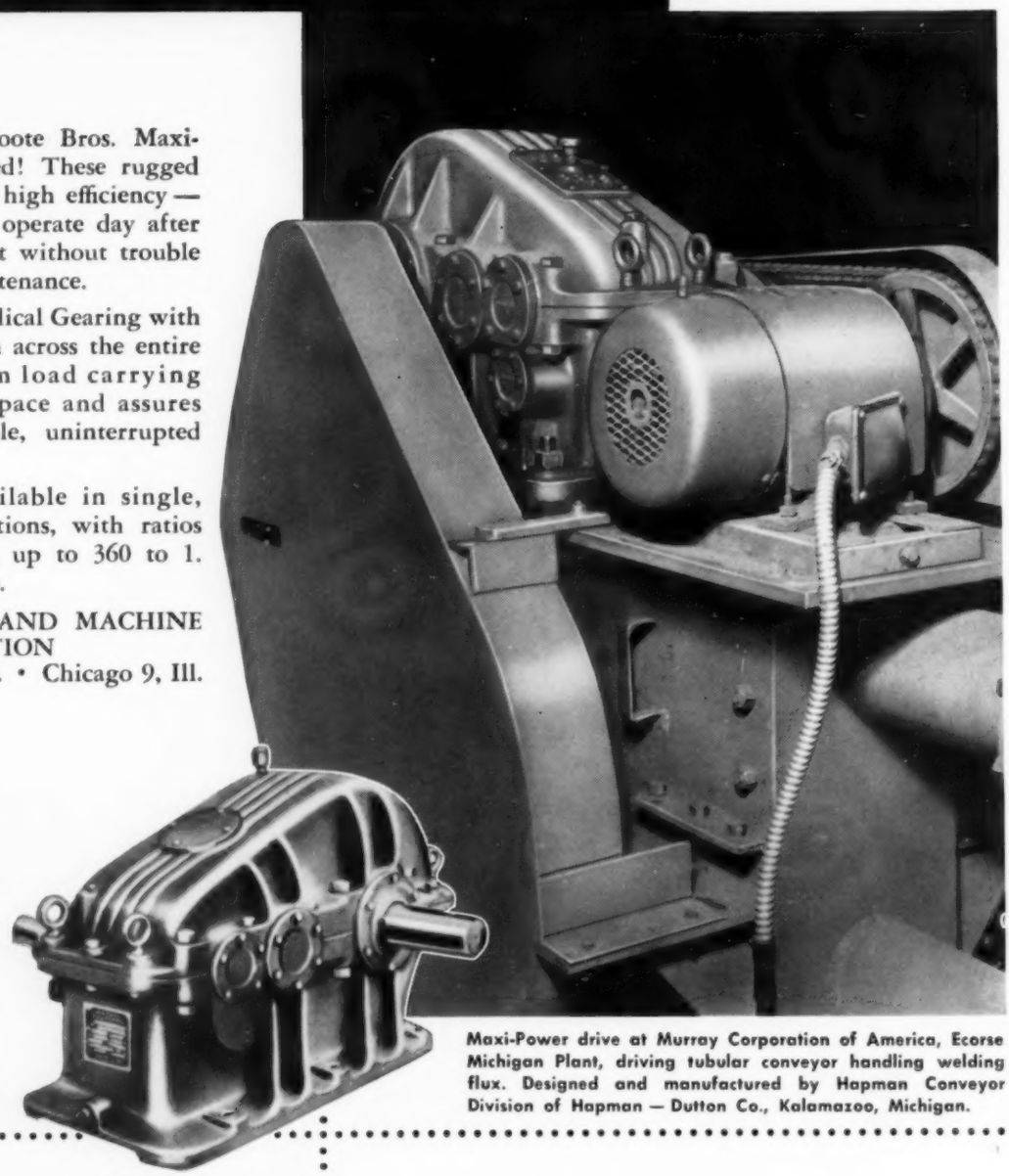

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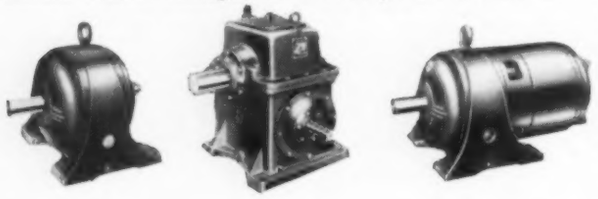

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Industry News...

REPUBLIC STEEL CORP. PRODUCES TITANIUM AT CANTON AND MASSILLON, OHIO

▲ Republic Steel Corp. announced recently that it is producing titanium and titanium alloys, the new "wonder" metals, at its Canton and Massillon, Ohio steel plants.

Republic, the nation's third largest steelmaker, is the largest steel company to announce that it is working on the new metals.

Titanium is only 56 per cent as heavy as alloy steel, yet comparable in strength. This weight advantage, together with its corrosion resistance, makes it especially desirable for use in the aircraft and other industries where both strength and lightness of metals are desired.

Titanium in many cases equals or exceeds stainless steel in its ability to resist corrosion. Preliminary results with alloyed titanium indicate it has higher strength to weight ratios than any other commercial metal.

Republic is the world's largest producer of alloy and stainless steels. The processing and rolling of titanium and titanium alloys, aside from melting, is similar to that of alloy and stainless steels. Thus it is expected Republic's large team of research, metallurgical and production personnel may be expected to contribute substantially to the development and production of the new metals in commercial quantities.

Republic said it has been supplying titanium and titanium alloys in ingot, sheet, plate, strip, bar and wire forms for the last two years for aircraft and other defense programs. Production is still limited and is under strict allocation by the government.

Titanium is melted by Republic at its South Division plant in Canton, Ohio, by both the arc and induction methods. The company has several small furnaces in experimental production and is planning to install additional equipment for both melting and processing.

Induction melting is carried out in a very dense grade of graphite under an atmosphere of inert gas—either argon or helium. In arc melting, specially prepared sponge is fed continuously into a water cooled copper crucible under an inert gas atmosphere and melted with a direct current graphite, tungsten or other type electrode.

Of the two methods of melting, indications are that the arc melted product would find most widespread application.

Alloy content of titanium alloys probably will not exceed 15 per cent, with most high strength grades running between 4 and 10 per cent. Included among the alloys are iron, chromium, manganese, aluminum and many others.

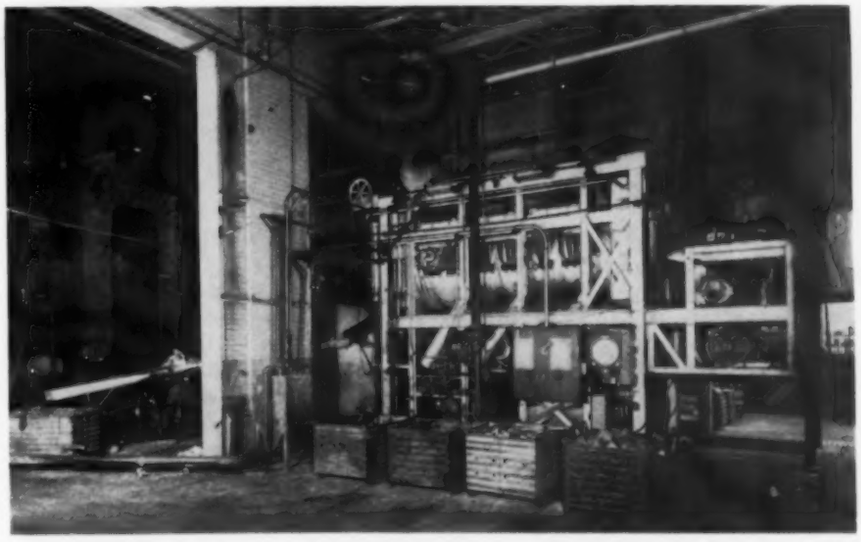
Major production is confined to the commercially pure product, but Republic is doing considerable development work on the chromium-iron and manganese alloys. Other alloys can be modified to give variations in properties so that a fairly wide range of physical properties is possible.

NEW TINPLATE MILL SHIPS AHEAD OF PLAN

▲ The first shipments of tin plate from the new tin plate mill of Kaiser Steel Corp. at Fontana, Calif., were en route to customers on August 5.

The company had originally scheduled shipments of tin plate to begin in October, after the completion of a series of tests of the new mill's equipment. But with the sudden severe scarcity of tin plate brought on by the recent national steel strike the mill operators speeded up the tests by working literally around the clock, thereby attaining earlier commercial

HIGH SPEED FURNACE FOR FORGING



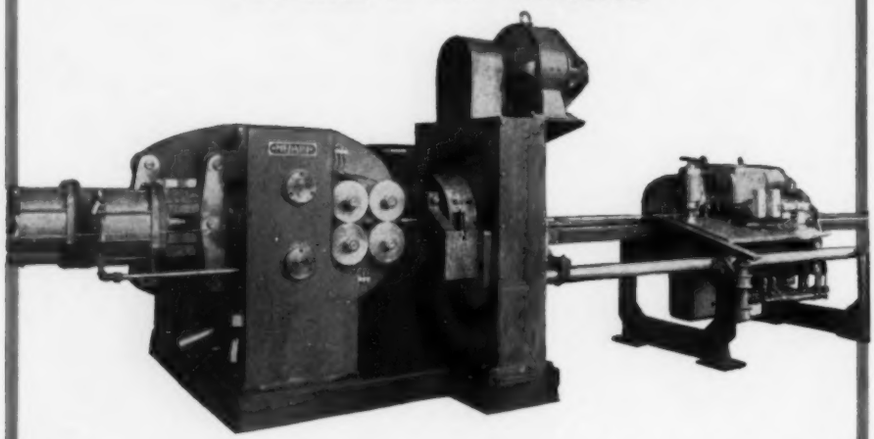
This Surface Combustion gas-fired radiant wall high speed furnace heats 1¼ x 3⅜ x 23 in. billets to 2350 F in 6.18 minutes for press forging such automotive parts as ring gears and connecting rods. A production rate of 8100 lb per hr can be maintained. During die change shutdowns, billets under heat are protected from scale by closing flue dampers, admitting a reducing air-gas mixture through the burner nozzles and holding heated charge under the resulting protective atmosphere. Changeover is almost instantaneous and operations automatically synchronized, with "push-button" control.

Triple Production or Better on Bar & Tube Turning!

MEDART

RFPD AUTOMATIC CENTERLESS BAR TURNERS

FOR BARS ¼" to 6" DIAMETER



- The unsurpassed production speeds of the RFPD Turner using carbide cutting tools—up to 12 ft. per minute—average from 3 to 4 times that of conventional turners by actual comparison.
- Material turned on this machine can be sold directly from the machine for "as turned" stock, put through the Medart two-roll rotary straightening, sizing and polishing machines for "turned and polished" stock, or given one pass through a centerless grinder for "ground" stock.
- The RFPD turning gives 100% material recovery with short, easy-to-handle chips.
- Direct-drive cutterhead, through single V-belt drive, is a single compact unit designed for either brazed tip or mechanically held carbide tools.
- Controls provide fully automatic push-button operation through entire cycle, and supplementary manual operation for setup. Both speeds and feeds are infinitely variable.

Many other cost-reducing, time-saving exclusives are offered in the RFPD Centerless Bar Turner.

Write For Illustrated Brochure

THE MEDART COMPANY 3535 De Kalb Street St. Louis 18, Mo.

production to help alleviate the shortage of cans for the current fruit and vegetable packing campaign.

The first shipments totaled 412 tons of tin plate. On the average, this is sufficient to make nearly three million No. 2½ tin cans.

Additional shipments will be made as rapidly as the tin plate is finished in order to keep a steady flow of material going to can producers and thence to the canneries.

The first shipments were "hot dipped" tin plate. With the starting up next month of the electrolytic line the output will be stepped up.

The new mill, covering an area of nine acres and costing over $20,000,000, will have an annual rated capacity of 200,000 tons of tin plate when it gets into full production.

HAGAN PURCHASES GREY IRON FOUNDRY

▲ Hagan Corp., combustion and chemical engineering firm, has purchased American Cast Products, Inc., Orrville, Ohio, Hagan president D. J. Erikson announced recently.

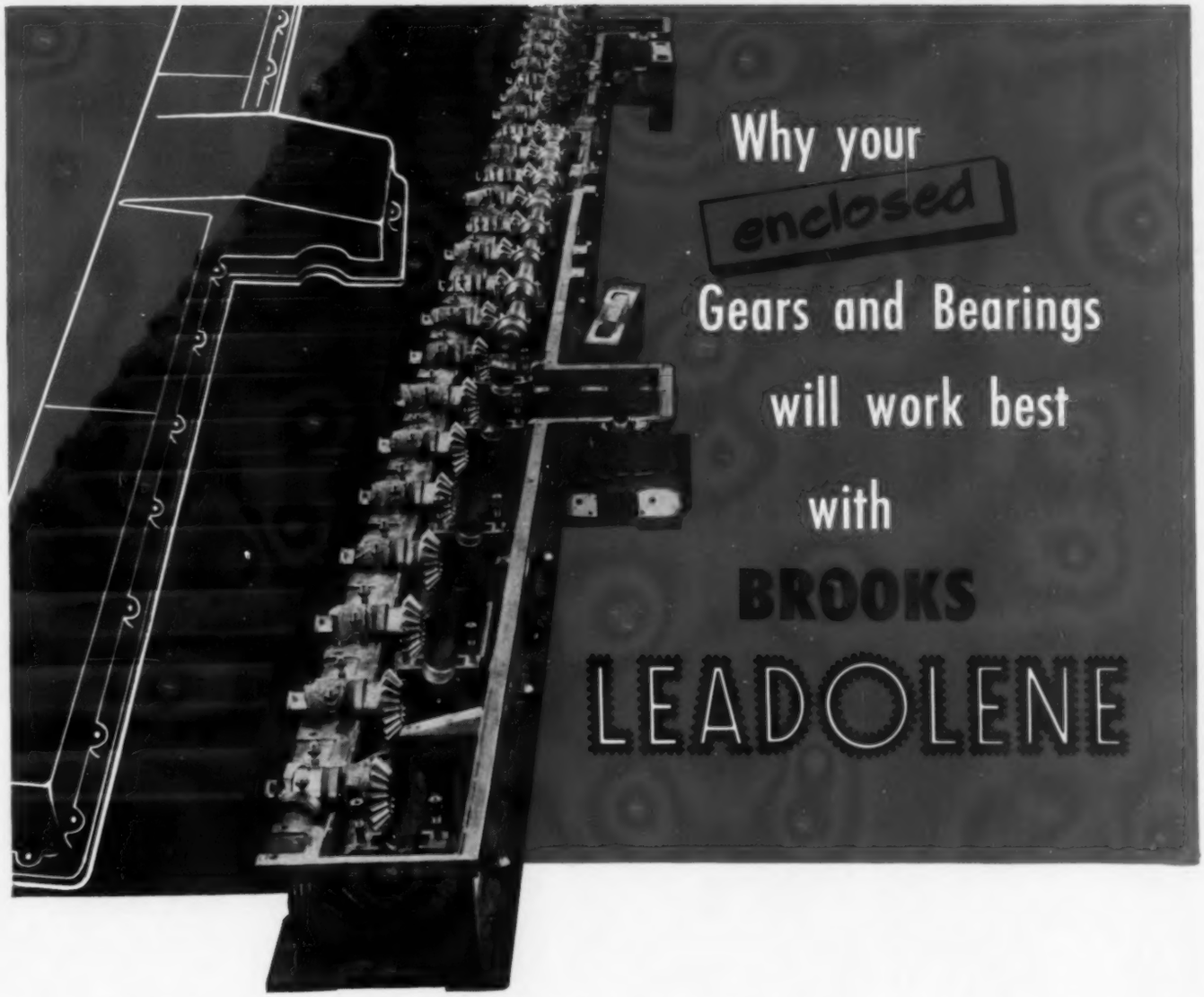
No personnel changes are contemplated in organization of this old-established grey iron foundry, Mr. Erikson said. Neil A. Benson, plant manager, Hagan Orrville plant, will directly supervise operations of American Cast Products, Inc., as a wholly owned subsidiary. J. Carl Hall will continue as sales manager of the foundry and assist in its operation.

The foundry will continue to serve its customers for grey iron castings under the same manufacturing and sales policies, Mr. Erikson explained. Hagan Corp., as manufacturer of combustion and process control systems, flow meters and other products requiring castings, is one of many old customers of the foundry.

The new subsidiary is directly across the street from the automatic control and flow meter plants of Hagan Corp. in Orrville. Home office of Hagan Corp. is in Pittsburgh, Pa.

WEIRTON BUILDS NEW HARBOR FACILITIES

▲ Contract for construction of new harbor facilities at the Weirton, W. Va. plant of Weirton Steel Co. has been awarded to the contracting division of Dravo Corp.



Enclosed gears . . . with their close tolerances, high speeds, shock loads, and great bearing and tooth loads . . . operate best when protected by Brooks LEADOLENE. With its "Indestructible pH-ilm Strength," this lead-based lubricant is definite assurance against pitting, galling, finning of teeth and abnormal bearing wear. The lubricating efficiency of LEADOLENE is not affected by water.

The following case history indicates the kind of service you can expect from LEADOLENE: "*Although a good quality lubricant was used in a certain Cleveland plant's enclosed gear reduction units . . . the gears, bearings and shaft journals required replacement so frequently that the reductions were taken apart every four months. At that time they were cleaned, some replacements were made and new lubricant was added. When LEADOLENE No. 90 was adopted as the lubricant, the reductions were operated for over two years with no replacements and no serious wear.*"

For reduction gear sets . . . mill table gear drives . . . or any other enclosed gear application—you will profit by standardizing on Brooks LEADOLENE as your lubricant.

WRITE for the 20-page brochure, "The Brooks Oil Story". . . or for consultation by a Brooks Engineer.

With LEADOLENE you get these characteristics

pH-ilm Strength . . . 30,000 psi minimum.

Adhesiveness . . . Affinity for metal develops maximum adhesion providing permanent coating on gears.

Water Repellence . . . Effectiveness is not reduced by water.

Corrosion Prevention . . . Never acidic and will not etch or corrode.

Compounded Stability . . . Will not bleed or change physical condition within a greater temperature range.

Low Temperature Factors . . . Does not harden, crack or decrease in adhesion.

Abrasive Resistance . . . Repellent to adhesion of scale, metallics and other contamination.

THE BROOKS OIL CO.

Since 1876

Executive Offices and Plant	Cleveland, Ohio
Executive Sales Offices	Pittsburgh, Pa.
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- OPERATING ECONOMY
- GREATEST DURABILITY
- LOWEST MAINTENANCE

Visit Ready-Power in Booths 11 and 12 at the Iron & Steel Exposition, Cleveland Public Auditorium, September 30 through October 3.

You can save REAL money on the operation of electric trucks. Ready-Power DIESEL-Electric drive is the answer. Actual tests prove savings of 40% to 70% in operation and maintenance. Rugged DIESEL design provides *more* work per gallon of fuel, *longer* life span and *less* maintenance. And Ready-Power DIESEL-Electric Units provide the most efficient, most constant, most economical power source for electric industrial trucks.

Remember... Your Truck Is No Better Than Its Power!

CONTINUOUS-DUTY POWER UNITS

The READY-POWER Co.

3836 Grand River Ave., Detroit 8, Michigan

Manufacturers of Gas and Diesel Engine-Driven Generators and Air Conditioning Units; Gas and Diesel-Electric Power Units for Industrial Trucks

The harbor, 1796 ft long, adjoins Weirton's present river docking facilities which also were constructed by Dravo.

A 400-ft long loading dock, consisting of five 54-ft diameter connected circular steel sheet pile cells, will be constructed near the upstream end of the harbor. At this location Weirton will erect a new warehouse, 150 ft long by 60 ft wide, equipped with an overhead crane to load and unload barges and railroad cars.

In addition to the five dock cells, there will be one 30-ft diameter supporting cell, two 40-ft diameter ice breakers at the upstream end of the harbor, 14 barge mooring cells of 16-ft diameter, and four 40-ft diameter cells to divert sewer flow and support a new two-track railroad trestle leading to the dock.

To provide necessary depth in the harbor for barges, Dravo will remove some 27,000 cu yd of rock from the river bed. A special barge is being equipped to handle underwater drilling, loading and shooting of dynamite. Rock shot out will be placed as rip rap on the steep river bank. It will also be necessary to dredge about 25,000 cu yd of river deposits to deepen the harbor.

STAMPING FIRM MOVES TO NEW LOCATION

▲ M. E. Cunningham Co., manufacturer of safety steel stamps, dies and other marking tools, has acquired a new plant in Pittsburgh, Pa., according to Frank Speicher, Sr., president. The new plant will have more than double the working space than was available in the South Side Pittsburgh site where the company had been located since 1928.

In moving into its new plant M. E. Cunningham has acquired additional metal working and heat treating equipment to handle increased production. The increased floor space also will permit a more efficient production arrangement, Mr. Speicher emphasized.

Established in 1889 as a manufacturer of rubber stamps, the company gradually came to concentrate on steel stamps, dies and special marking tools which are used in every industry.

M. E. Cunningham's new plant is at North Avenue and Chateau Street. The old location was 115 East Carson Street.

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A. Get McDowell!

By *complete responsibility* we mean design and construction of foundations, and / or housing - as well as installation of mill equipment, or mills, delivered in ready-to-operate condition. Our talented forces work from the solid engineering perspective of experience, plus the quick-witted, freethinking, intimate understanding of mill procedures which we call the McDowell Method. This Method continually earns the friendship of the builders of equipment and of mill men everywhere. Its versatile comprehension is ready now, to serve you.

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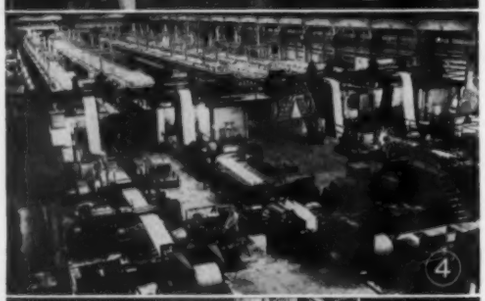
AMBLER ACP PENNA.

Technical Service Data Sheet
Subject: EFFICIENT PICKLING WITH RODINE®

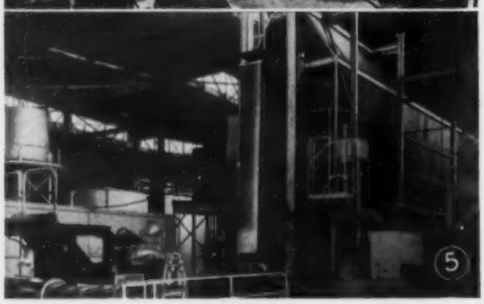
1. Rod and wire are pickled clean with "Rodine" without wasting either acid or metal. Breakage in drawing due to acid brittleness is minimized.

2. "Rodine" protects the exterior of tubes while completely descaling the interior and minimizes breakage in drawing due to acid brittleness.

3. "Rodine" makes possible the batch pickling of sheets over a wide range of acid concentration and temperature.



4. Whether sheet steel is pickled continuously or in batches, "Rodine" improves the surface and prevents "pickle burning" in prolonged pickling.



5. The absence of pitting and the smoother surface obtained with "Rodine" saves expensive coating metal in electrolytic tinning and galvanizing.

CHEMICALS ACP PROCESSES

WRITE FOR DESCRIPTIVE FOLDER ON "RODINE" AND INFORMATION ON YOUR OWN PICKLING PROBLEM.

CHEMICALS ACP PROCESSES

ALCOA UNDERTAKES ALASKAN SMELTING UNIT

▲ Aluminum Co. of America will undertake the construction of a 400-million-dollar aluminum smelting project in Alaska as soon as the necessary land can be purchased and government approvals obtained, the company said today.

Speaking on August 23 at Mt. McKinley National Park, Leon E. Hickman, vice-president and general counsel for Alcoa, outlined the details of an Alcoa-Alaska project which would initially be capable of producing 200,000 tons of aluminum annually.

The Alaskan smelting facilities, and electric power developments necessary to operate them, would be situated in the Taiya Valley district, near Skagway, Alaska. Financing of the project would be done entirely with private capital, Mr. Hickman said.

The project would be the largest in Alaska to provide employment every day of the year, and would be a great step forward in the industrial development of the territory, he stated.

He estimated that the Taiya development would require about four years for completion, and would eventually offer employment for approximately 4000 people when full scale operations were under way.

ROLL STAINLESS STEEL AT VANDERGRIFT, PA.

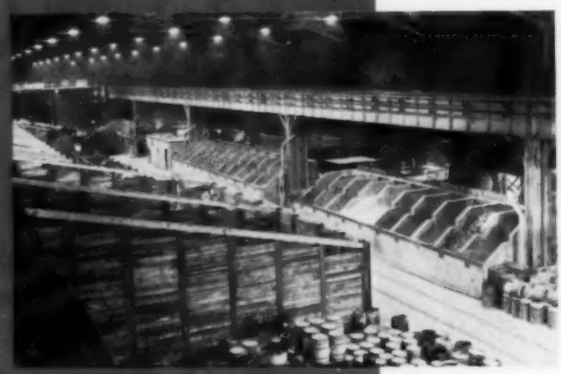
▲ The production of hot-rolled stainless steel, normally rolled in the hot mills at Wood works in McKeesport, Pa., will be transferred to the Vandergrift, Pa. plant, it was announced recently by United States Steel Co. The move was decided upon after successful experiments recently were completed in stainless steel rolling on existing equipment at Vandergrift.

The change, scheduled to take place within the next month, involves relocating about 150 employes of Wood works. Certain of these employes will be transferred to Vandergrift, while others will be offered positions in other plants of the company, including the new Fairless works.

The only change at McKeesport will be the elimination of hot rolling facilities. Other operations will be continued there as usual, including

Freyn-Design

ELECTRIC FURNACE SHOPS



Views of New Shop
Constructed For
Allegheny Ludlum Steel Corp.
at Watervliet, N. Y.

Freyn Engineering Department of Koppers Company, Inc. is prepared to engineer and to construct turnkey installations or to function in such manner and degree as you may prescribe

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how do your materials handling methods *Measure Up?*

An inventory of your materials handling methods might be profitable to you today. Are your methods of getting materials through production processes really modern methods? Are you getting finished products to storage or shipping via the best and most economical way? In other words, has your materials handling kept pace as you have grown and expanded your production?

A **little time** invested in a close look at your handling methods might save you **many dollars.** Possibly, being so close to your own everyday problems, you have overlooked some things that could be improved. Look over your operations again . . . and, if you see room for possible improvement, call in your nearby Mathews' Engineer. He'd like to help you to get better and more economical materials handling.

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CANADIAN DIVISION . . . . . *Mathews Conveyer Company, Ltd.*
PORT HOPE, ONTARIO

finishing and shipping of stainless steel.

The hot rolling operations are being consolidated at Vandergrift due to the availability of more modern facilities there and because the move will provide fuller working schedules for all concerned.

BROOKS OIL FORMS INTERNATIONAL UNIT

▲ The Brooks Oil International Co. has been formed to market the products of Brooks Oil Co. in countries outside of the western hemisphere, according to an announcement by Fred H. McCurdy, president.

Incorporated on August 9, 1952, the new company has established sales offices in Bern, Switzerland; Paris, France; Brussels, Belgium; Rome and Milan, Italy; and in Denmark, Sweden, Norway and Finland.

Officers of the company are: Alfred W. Ward, chairman of the board; Fred H. McCurdy, president; Joseph A. Rigby, vice president; Ray T. Joyce, secretary; Alfred B. Garson, treasurer; and Lois R. Reber, export manager. Executive offices are at 3304 East 87th Street, Cleveland; executive sales offices are at 934 Ridge Avenue, Pittsburgh.

Brooks Oil specializes in the manufacture of lead-based industrial lubricants which are used in the steel, aluminum, railroad, coal mining, sugar, chemical, power, automotive, cement and other industries.

RUST BUILDS FURNACE AT NATIONAL ROLL

▲ A new car type heat treating furnace is being installed by Rust Furnace Co. at National Roll and Foundry Co., Avonmore, Pa.

The new unit will increase the company's heat treating capacity for production of rolls and commercial castings, as well as tank armor castings which the company has been producing for the defense program since the latter part of 1950.

The new furnace is similar to five units that Rust installed at National during World War II, except that they were gas fired, and for the new furnace a combination of fuel oil and natural gas will be utilized.

Installation of the new furnace, which is expected to be completed

THIS IS THE C&D BATTERY THAT'S *helping produce America's steel!*

C&D Slyver-Clad battery
Type 36-CHS-17
36 cells, 880 amp. hours
60.50 K. W. hours cap.

● **C&D recently supplied the United States Steel Company with a number of these 7652 lb. giants. Installed in a massive ram truck, each battery supplies power to lift 10,000 to 20,000 lb. rolls of sheet steel—part of U. S. Steel's defense production.**

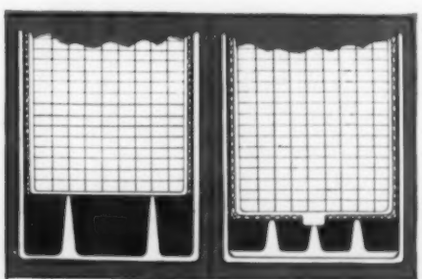
It's a tough, grueling job for any battery. But these 36-cell C&D *Slyver-Clads,* packed with power for a *full* work shift, are built to do it—day after day. That kind of performance is usual for *all* C&D industrial truck batteries!

SLYVER-CLAD . . .

An exclusive with C & D, giving the User the finest retention available. *Slyver* (infinitely fine *parallel* glass fibers) is placed vertically against each positive plate's surfaces and around the bottom. Four more specifically designed layers (two glass expansion mats, a Koroseal retainer, and microporous rubber separators) complete C&D's Five-Fold insulation and retention. Active material is securely held in place where its power-producing ability can be utilized throughout the life of the battery. Sedimentation being practically nil, C&D has used what is normally non-productive sediment space for longer plates. Thus, within the same physical dimensions of the conventional battery, C&D has built *the* maximum capacity industrial truck battery.

Your plant, too, deserves the extra advantages of these better batteries! Put them to work in *your* trucks now! Write for:

IT-515 INDUSTRIAL FORK TRUCK BULLETIN
IT-516 MOTORIZED LIFT TRUCK BULLETIN



COMPARE THEM! At left: an ordinary battery with large, unproductive sediment space and integrally molded supporting ribs. At right: a C & D Slyver-Clad showing longer, power-producing plates. Separate rib plate in new double bottom design distributes battery weight evenly over jar base. Negative plates rest on separate center rib.

C&D

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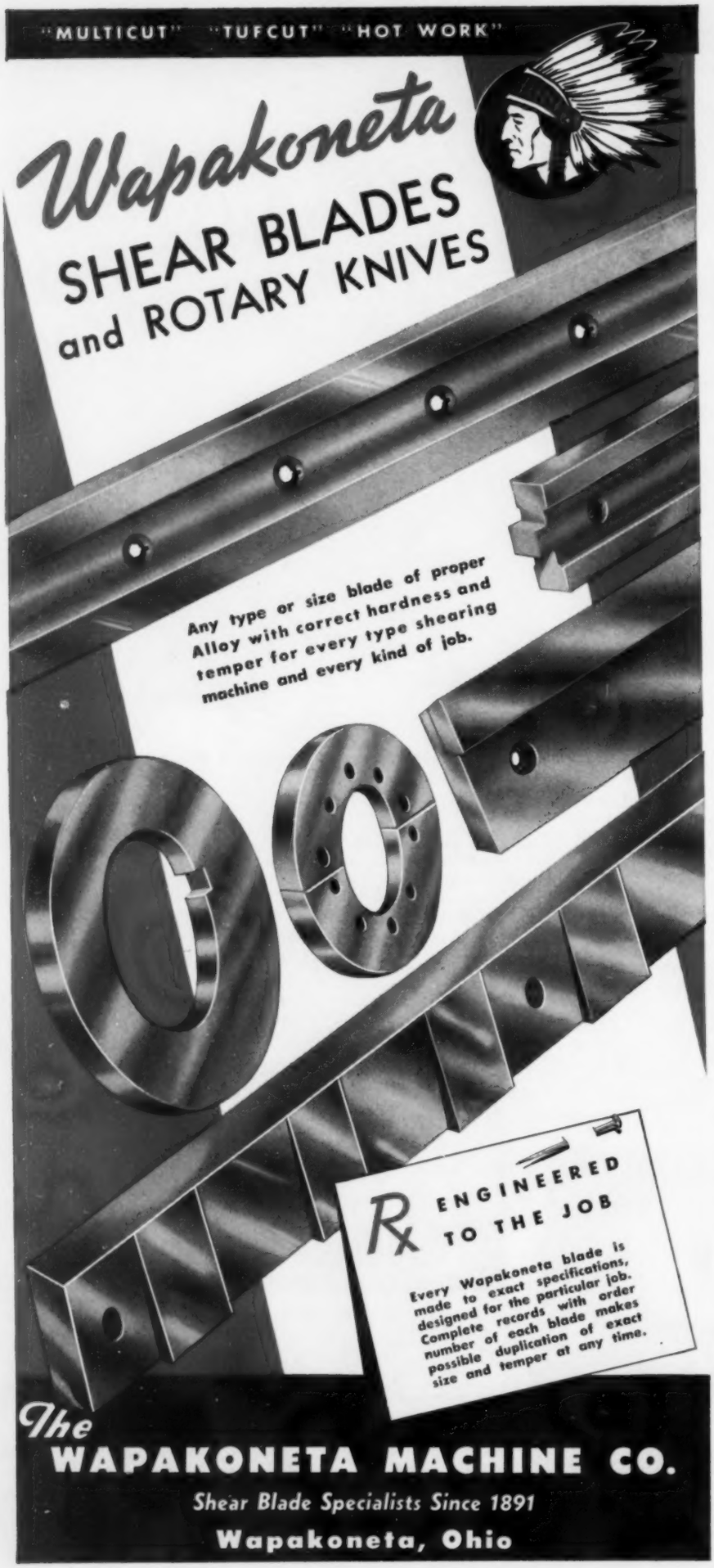
"MULTICUT" "TUFCUT" "HOT WORK"
Wapakoneta
SHEAR BLADES
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Any type or size blade of proper Alloy with correct hardness and temper for every type shearing machine and every kind of job.
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Every Wapakoneta blade is made to exact specifications, designed for the particular job. Complete records with order number of each blade makes possible duplication of exact size and temper at any time.
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Shear Blade Specialists Since 1891
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this summer, is the latest step in the extensive expansion and modernization program which National Roll has been carrying out over the past few years in its machine shop, foundries, pattern shops and laboratories. Improvements included replacement of machinery and equipment as well as several new structures and additions to existing structures.

NEW BLAST FURNACE FOR GERMAN PLANT

▲ H. A. Brassert and Co., Inc., New York, N. Y., has concluded negotiations with Dr. Harr, general director, and Dr. Guldner of Westfalenhutte A.G. Dortmund, Germany, for the engineering and supervision of construction of a new blast furnace, according to an announcement by Frank Senior, president.

The new furnace will be located at the company's principal works at Dortmund, Germany, and will have an initial hearth diameter of 26 ft 6 in. with provision for expanding to 28 ft. It will be of modern American design in its principal features and will be the largest blast furnace in Europe.

This furnace will have the effect of increasing Westfalenhutte's ingot capacity from approximately 1,200,000 tons to 1,700,000 tons per year.

The engineering will be performed in the Birmingham, Ala. office of the company and the furnace will be fabricated in Germany and erected under the supervision of H. A. Brassert and Co. It is anticipated that the unit will be blown in late in 1953.

ALLIS-CHALMERS FORMS NEW SERVICE UNIT

▲ Organization of a field group to provide Allis-Chalmers general machinery division customers throughout the country with a maximum of fast and efficient service has been announced.

The newly organized group is operating under the direction of C. W. Schweers, vice-president and director of sales. It will handle all service, repairs, breakdowns, and adjustments in the field. Delivery and erection of new equipment, major overhaul jobs, special service work, and major repairs requiring special skills or long period manpower assignments will continue to be handled from headquarters at Milwaukee, Wisc.

Leaders OF INDUSTRY THE WORLD OVER

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Allegheny Ludlum Steel Co.
American Steel & Wire Co.
Armco Steel Corporation
Bethlehem Steel Company
Carnegie-Illinois Steel Corp.
Cleveland Wire Works (G.E.)
Consolidated Vultee Airc. Corp.
Continental Steel Company
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Crown Cork & Seal Company
Empire Steel Corporation
Follansbee Steel Company
Jones & Laughlin Steel Corp.
Hofmann Industries
Mercer Tube Company
Mesta Machine Company
National Tube Company
Niles Rolling Mill
Parkersburg Steel Company
Reeves Steel & Mfg. Co.
Revere Copper & Brass, Inc.
Rochester Can Company
Sharon Steel Corporation
Superior Sheet Steel Co.
Tennessee Coal, Iron & R.R. Co.
Valley Manufacturing Company
Vilsack Fisher Mfg. Co.
Wheeling Steel Corporation
Wickwirc-Spencer (C.F.&I.)
Youngstown Sheet & Tube Co.

*CANADA:
Dominion Foundries & Steel Co.

*ABROAD:
A.R.B.E.D. Co., Luxembourg
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*(List is incomplete and growing)

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SOAKING PITS, regenerative and one-way recuperative,
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And Other Complete Heating Lines

In America and abroad, F.E.I. is recognized for top performance. You can rely on Furnace Engineers' skill, based on over 30 years' experience, to provide the most advanced heating methods. F.E.I.'s patented, automatically controlled combustion system provides high metallurgical quality and faster, more economical operation. Remember, F.E.I. is the complete buy . . . from plan to production.

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F E I *Furnace Engineers, Inc.*
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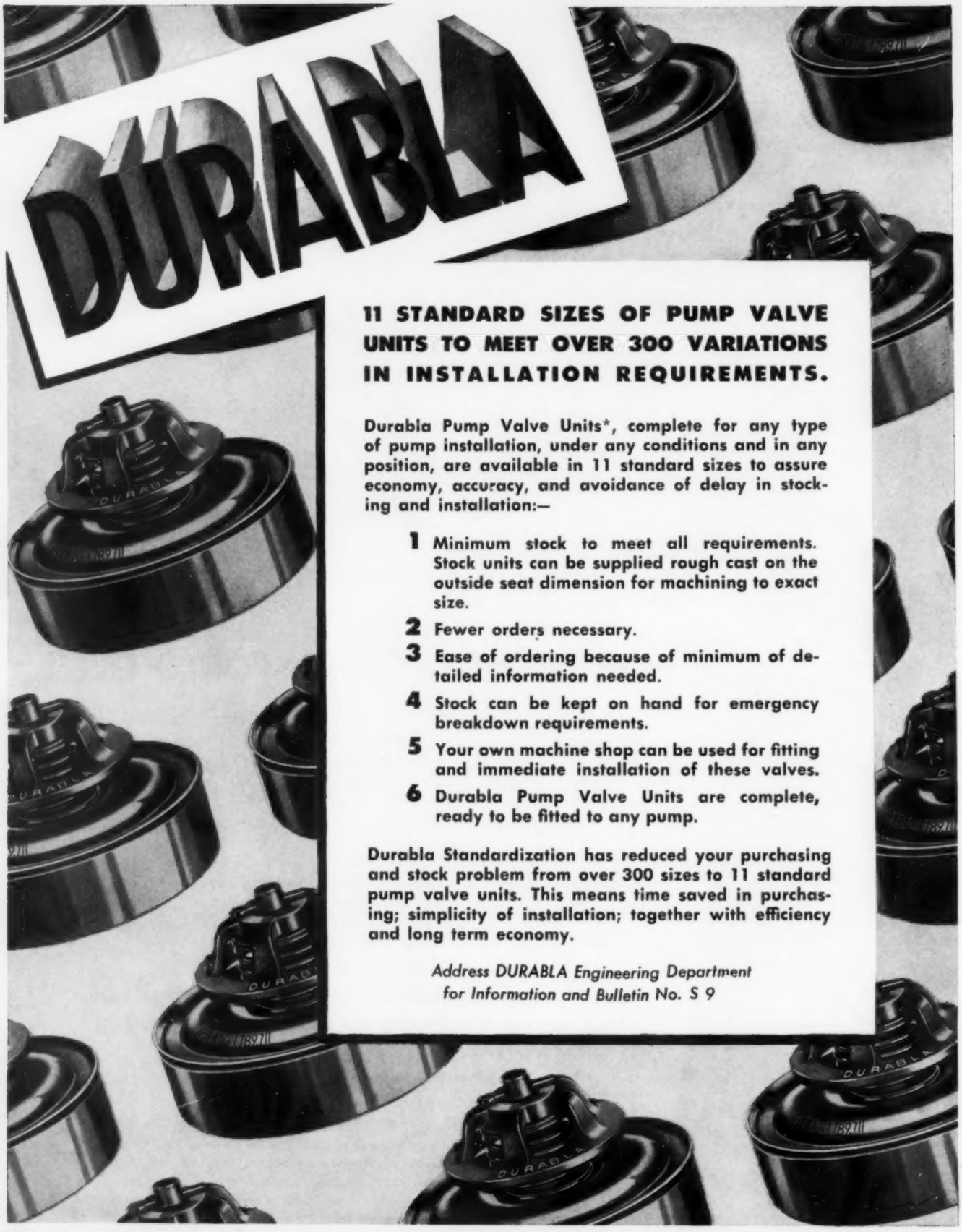
AFFILIATES — *Great Britain:* Salem Engineering Co., Ltd., Milford near Derby, England. *France, Belgium, Holland, Luxembourg and Italy:* Heurtey & Co., 38 Av. G. Mandel, Paris XVI, France.



11 STANDARD SIZES OF PUMP VALVE UNITS TO MEET OVER 300 VARIATIONS IN INSTALLATION REQUIREMENTS.

Durabla Pump Valve Units*, complete for any type of pump installation, under any conditions and in any position, are available in 11 standard sizes to assure economy, accuracy, and avoidance of delay in stocking and installation:—

1. Minimum stock to meet all requirements. Stock units can be supplied rough cast on the outside seat dimension for machining to exact size.
2. Fewer orders necessary.
3. Ease of ordering because of minimum of detailed information needed.
4. Stock can be kept on hand for emergency breakdown requirements.
5. Your own machine shop can be used for fitting and immediate installation of these valves.
6. Durabla Pump Valve Units are complete, ready to be fitted to any pump.

Durabla Standardization has reduced your purchasing and stock problem from over 300 sizes to 11 standard pump valve units. This means time saved in purchasing; simplicity of installation; together with efficiency and long term economy.

Address DURABLA Engineering Department for Information and Bulletin No. S 9

*Patent Numbers 2090486, 2117504

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114 LIBERTY ST. NEW YORK
BRANCHES IN PRINCIPAL CITIES. FOR CANADA REFER: CANADIAN DURABLA LIMITED, TORONTO

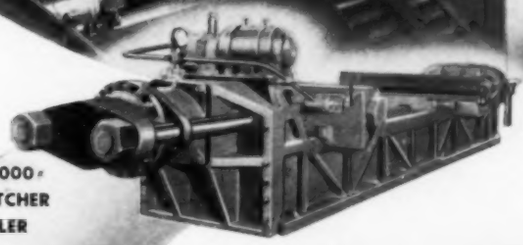
STEEL MILL *EQUIPMENT*

Precision built

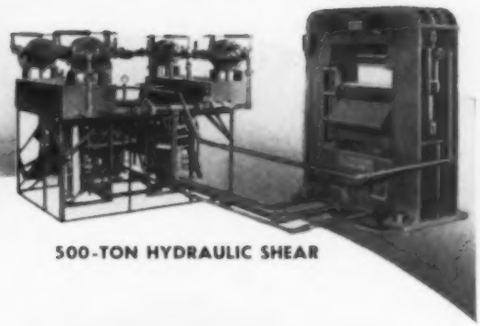
BY

F & Y M

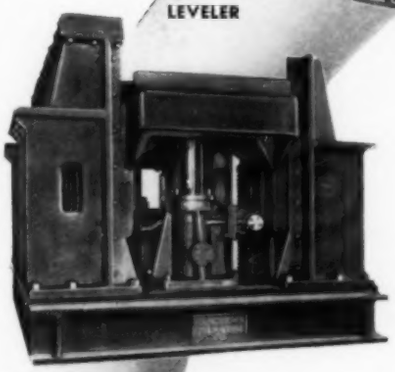
100" SCRUBBER LINE



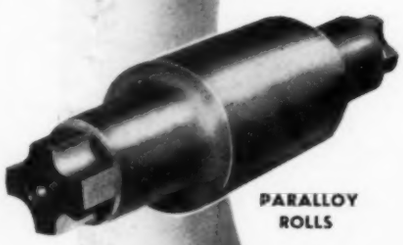
800,000# STRETCHER LEVELER



500-TON HYDRAULIC SHEAR



SLAB PILER



PARALLOY ROLLS

Check this List for the Products You Need

- PARALLOY ROLLS (Pinch, Coiler, Tension, Steel Mill)
- HYDRAULIC SLAB AND BILLET PILERS
- STRIP AND SHEET OILING EQUIPMENT
- SHEET SCRUBBER AND CLEANING LINES
- HOT SAWS—ROCKING AND SLIDE TYPES
- HOT BEDS—COOLING BEDS—TRANSFERS
- BILLET EJECTORS—PINCH ROLL STANDS
- SLITTERS—SPECIAL SHEARS AND GAUGES
- TILTING TABLES—Traveling and Lifting Tables
- Continuous PICKLING Lines—ROLLER LEVELERS
- FURNACE Charging Equipment—Furnace Pushers
- Strip Steel COILERS and REELS—SCRAP BALLERS
- RAILROAD Spike Forming Machines—ROLL LATHES
- Sheet GALVANIZING Lines—Wire Patenting Frames
- Stretcher Levelers—Angle and Shape Straighteners
- Rolling Mill Tables—Gear and Individual Motor Types
- DUCTILE CASTINGS (80,000 PSI.)

Machinery Built to Customer's Design and Detail Drawings

The Youngstown Foundry & Machine Co.

OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

Youngstown, Ohio

Banish the "Bite"

ON PICKLING AND PLATING EQUIPMENT

with these NATIONAL (TRADE-MARK) CARBON AND GRAPHITE AND KARBATE (BRAND) IMPERVIOUS GRAPHITE PRODUCTS

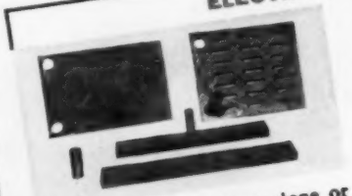
Pickling and tinning are messy, expensive – and *necessary*. However, you can *greatly reduce* equipment maintenance costs and improve plant housekeeping by making full use of these National Carbon products wherever service is dirty and tough. As is well known by manufacturers of your pickling and plating *solutions*, only carbon and graphite and impervious graphite withstand the "bite" of so wide a range of corrosive chemicals.

HERE'S WHERE THEY'RE USED:

STAINLESS PICKLING

Carbon brick tank linings with "Karbate" Plate-Type Heat Exchangers and drain lines offer powerful resistance to nitric-hydrofluoric solutions.

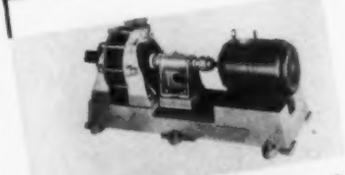
ELECTROLYTIC PLATING



Graphite Anodes, either alone or in combination with dissolving-type anodes, are non-contaminating and long lasting.

Various immersion-type and shell-and-tube type "Karbate" Heat Exchangers are available to suit capacity requirements.

CARBON STEEL PICKLING



"Karbate" pumps and piping resist sulphuric and hydrochloric acid attack . . . protect solution from contamination.

"Karbate" Shell-and-Tube Heat Exchangers are often most economical where more than 50 square feet of heat transfer surface is required.

Graphite Tank Rolls provide an ideal combination of good electrical conductivity and resistance to acid attack in electrolytic pickling operations.

WRITE FOR CATALOG SECTION—S-5005

The terms "Karbate" and "National" are registered trade-marks of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, New York

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
IN CANADA: National Carbon Limited, Montreal, Toronto, Winnipeg

OTHER NATIONAL CARBON PRODUCTS

BLAST FURNACE LININGS • BRICK • CINDER NOTCH LINERS • CINDER NOTCH PLUGS • SKIMMER BLOCKS • SPLASH PLATES • RUNOUT TROUGH LINERS • MOLD PLUGS • TANK HEATERS

Personnel News...

H. H. Shakely has been appointed works manager of the Otis works division, Cleveland, Ohio, Jones & Laughlin Steel Corp., replacing G. S. Ashmun who will be retained on the works manager's staff. Mr. Shakely was formerly assistant works manager—production, Pittsburgh, Pa., works division. **H. P. Saxer,** formerly assistant works manager—general services, Pittsburgh works division, is appointed to the position of assistant works manager—production, at the same works. **N. C. Atwood** is appointed assistant works manager—general services, succeeding Mr. Saxer. Mr. Atwood previously held the position of works industrial engineer.

Jonathan Jones has retired as chief engineer, fabricated steel construction, Bethlehem Steel Co., Bethlehem, Pa. **Ethan A. Ball** has been appointed to succeed Mr. Jones in that position. Until now, Mr. Ball has been assistant chief engineer, bridges and buildings, in the fabricated steel construction division. Taking Mr. Ball's place in this capacity is **W. H. Jameson,** since 1938 assistant engineer, bridges and buildings. Mr. Jones' retirement concludes a career of nearly half a century in steel construction, during which he gained recognition as one of the country's foremost structural engineers. A graduate in civil engineering in 1906 from the University of Pennsylvania, Mr. Jones was early associated with McClintic-Marshall Co., coming into the Bethlehem organization when the steel company acquired the construction firm in 1931.

Nixon A. Brewer has been appointed the new general manager of the Allegheny Industrial Electrical Co., Pittsburgh, Pa.

Lawrence Litchfield, Jr., has been elected president of Alcoa Mining Co., New York, N. Y., and of Surinaamsche Bauxite Maatschappij, Paramaribo, Suriname, both subsidiaries of Aluminum Co. of America. He succeeds **Frank B. Cuff,** who retired on August 1. Mr. Litchfield, who has been serving as vice president of Alcoa Mining Co. and Surinaamsche Bauxite Maatschappij, is a veteran of 27 years service with the company.

W. A. Finn has been named assistant general sales manager of Worthington Corp. Mr. Finn, who is returning from Paris, France, where he has been serving as general European manager, will now make his new headquarters at Worthington's Harrison, N. J. offices.

Raymond T. Whitzel has been made general manager of the smelting division of Aluminum Co. of America, succeeding **V. C. Doerschuk,** who has been general manager of that division since 1935. Mr. Doerschuk will become technical consultant, chiefly on aluminum smelting and related problems. Mr. Whitzel has been assistant manager of the smelting division since March, 1951.

Thomas W. Russell, Jr. was appointed general purchasing agent of American Brake Shoe Co. Mr. Russell joined American Brake Shoe as an apprentice in 1945 and served four years in the operating department. He entered the purchasing department as a buyer in 1949 and became assistant general purchasing agent in 1950.

William H. Old has joined Babcock & Wilcox Co. as director of purchasing. He will be located in the New York, N. Y., office of the company. Mr. Old was formerly general purchasing agent of American Brake Shoe Co.

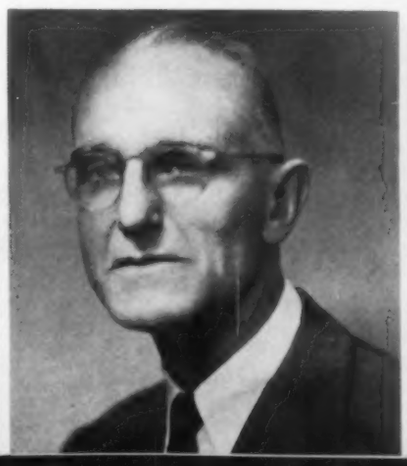
W. R. Shook was named manager of the new southeast district office of Electric Machinery Mfg. Co. Mr. Shook, who has had six years of specialized engineering and application experience in large electric motors, generators and controls in the Cleveland office, will make his headquarters at Atlanta, Ga.

Raymond J. Groh, supervisor of office service for United States Steel Supply division, has assumed general supervision of United States Steel consolidated office services and communications at 208 South LaSalle Street, Chicago, Ill. In addition to U. S. Steel Supply, whose headquarters are in Chicago, the move involved

H. H. SHAKELY

H. P. SAXER

JONATHAN JONES



ETHAN A. BALL

the following office service units of United States Steel: U. S. Steel Corp., public relations department, U. S. Steel Co., American Bridge division, American Steel & Wire division, National Tube division, Pittsburgh Steamship division and Universal Atlas Cement Co. The employes and facilities of these units of United States Steel formerly engaged in office services and communications have been transferred to the supply division. Under the new arrangement, Mr. Groh will be in charge of the combined mail rooms, telephone and telegraph facilities, typing pools, duplicating and printing equipment, stationery and supply rooms and the microfilming center.

George H. Shrewsbury has been appointed a sale representative for Harbison-Walker Refractories Co. Now assigned to the company's Pittsburgh, Pa., district, Mr. Shrewsbury formerly was a sales correspondent in Harbison-Walker's Pittsburgh office.

C. L. Peterson was named general sales manager of the industrial division of Minneapolis-Honeywell Regulator Co. Mr. Peterson has been regional manager for Honeywell's midwest region in Chicago since January, 1950.

A. Earle Cooke was named superintendent, plant protection, for Kaiser Steel Corp., Fontana, Calif.

Ralph M. Watson has been named director of research for Worthington Corp., Harrison, N. J. Mr. Watson assumed the post after the recent retirement of **Paul Diserens.** Since 1945 he has been serving as vice president in charge of engineering.

Dr. Soren H. Mortensen, chief electrical engineer for the power department of Allis-Chalmers Manufacturing Co., Milwaukee, Wis., and his assistant, **Fraser Jeffrey,** have both retired. Both men are pioneers in the electrical industry and are widely known through their numerous technical writings and appearances before engineering groups.

R. W. Davis, since 1949 special representative at Allis-Chalmers Norwood, Ohio works, has retired. From 1944 until 1949, Mr. Davis was general manager of the Norwood works.

Don E. Sweeney, formerly associated with General Motors Corp., is the new sales manager of P&H's diesel engine division, Crystal Lake, Ill., succeeding **R. H. Fitz,** according to an announcement from Harnischfeger Corp.

Fred D. Martin, former assistant plant manager in charge of plants 1, 2 and 4 of Speer Carbon Co., has

NOW...TWO NEW WAYS OF MARKING BILLETS

CUNNINGHAM Pneumatic BILLET MARKERS

See them at the
AISE SHOW
BOOTHS
81 and 82
1
2
MODEL 701 . . . for stamping ends of 4" x 4" and larger billets. Mounted on tracks above the conveyor, it impresses a legible mark by a swinging action.
MODEL 601 . . . can be set up for automatically marking either on ends or sides of billets. Interchangeable type holder can be made for any size or number of characters.
B12345

Thoroughly proved in service, these units were designed for stamping heat number, specification number, analyses or special coding on hot billets. With both of these Billet Markers, the operator remains at a safe, comfortable distance from the steel being marked.

Write for additional details

M.E. CUNNINGHAM CO.
SAFETY STEEL STAMPS
1041 Chateau Street • Pittsburgh 33, Pa.

Lee Wilson

ANNEALING FURNACE DATA SHEET

NUMBER SIX

BASIC ADVANTAGES OF LEE WILSON SINGLE-STACK PORTABLE BASE FURNACES:

1. BETTER QUALITY
2. HIGHER PRODUCTION
3. LOWER FUEL COSTS
4. LOWER FIRST COST
5. LOWER MAINTENANCE
6. LOW HANDLING COSTS

SINGLE-STACK PORTABLE BASE SYSTEM SIMPLIFIES HANDLING

Because handling can become a definite cost factor in annealing departments there has always been the question of comparative handling expense of one large furnace as against several small ones.

Lee Wilson, in developing the revolutionary Portable Base Single-Stack System, made a careful comparison study of the moves required to produce 1000 tons-per-month by using single-, 4-, or 8-stack furnaces. (See Fig. 1) For all practical purposes the number of moves is the same.

However, because the single-stack furnace and inner cover is much lighter and smaller, lighter and faster handling equipment can be used to do the work. Operators find handling easier. This enables them to make the moves on the smaller single-stack furnaces much faster.

Then, too, by adopting the Portable Base Single-Stack System, users find they can operate in reduced space requirements, yet produce the same tonnage. Handling equipment can operate constantly almost directly over the annealing bay . . . there's no travel to storage for inactive furnaces or inner covers. The spaces between the single-stack bases provide ample room for inner covers during loading and unloading. (See Figs. 2 and 3) Here are additional savings in handling time and labor.

Compare handling and you'll choose the Lee Wilson Portable Base Single-Stack System over all others. For that matter, compare the Lee Wilson System feature by feature with any other type annealing and you'll find this new approach to annealing enables users to do a better job faster — to get more flexibility into their annealing departments . . . to cut down time and maintenance costs to an absolute minimum.

Before you buy additional annealing equipment . . . check with Lee Wilson. Get all the facts about the amazing new Portable Base System. Write for illustrated brochure that fully explains the system.

1000
TONS PER MONTH

AVERAGE TONS PER STAND 40
AVERAGE STACKS PER MONTH 25

CRANE MOVES ····	8-STACK	4-STACK	1-STACK
COILS 3 COILS LOADING / 3 COILS UNLOADING	150	150	150
CONVECTORS 2 CONVECTORS LOADING / 2 CONVECTORS UNLOADING	100	100	100
INNER COVERS - 1 PER STACK	25	25	25
FURNACE MOVES	3	6	25
	278	281	300
MOVES SAVED PER MONTH	22	19	0

Fig. 1 — Table indicates negligible savings in crane movements of multiple-stack furnaces over single-stack type; the lighter, easier-to-handle single-stack furnaces require lighter handling equipment — more than nullifying the small labor-saving advantages of the multiple-stack type.

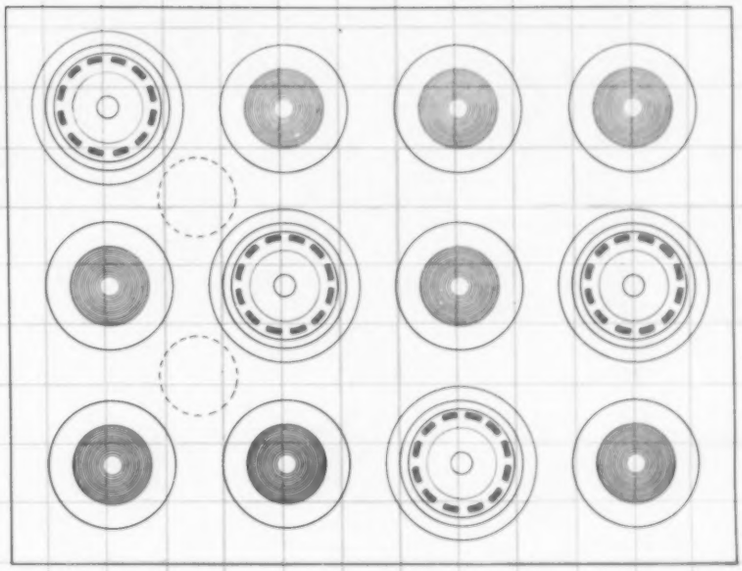


Fig. 2

Figs. 2 and 3 — Lower area requirements of Single-Stack System provide ample space for inner cover storage between bases. Handling can be made easier and faster, without long crane runs to storage areas. Lighter furnaces require only light building structure and handling equipment.

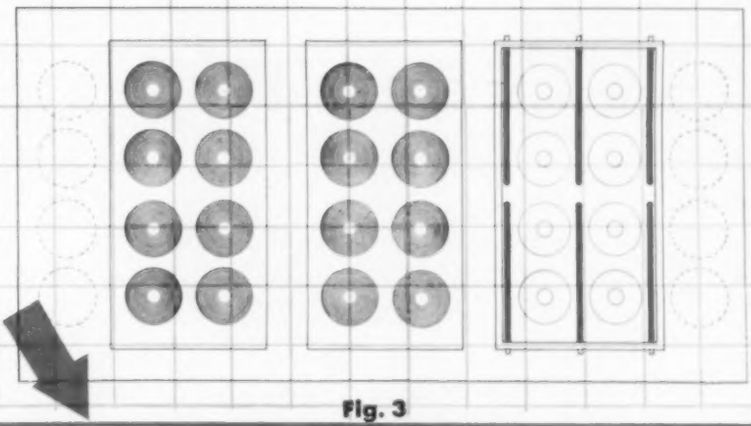


Fig. 3

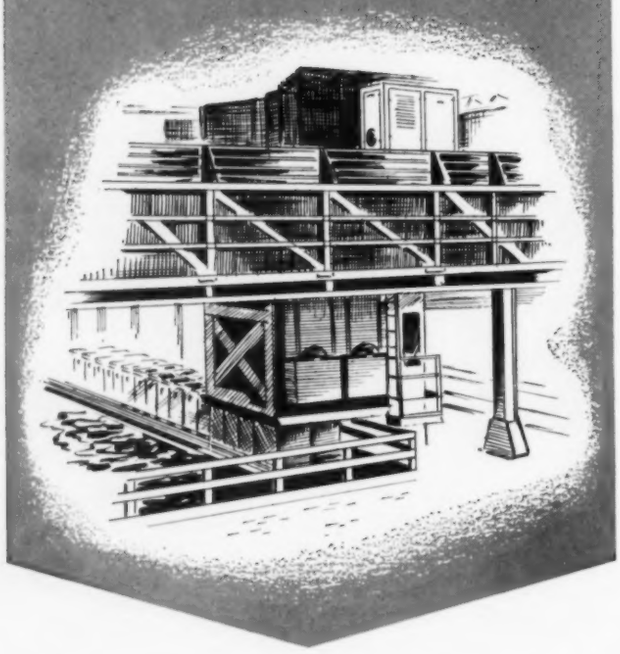
SEE scale model of the new convector type single stack portable base in Booth 80, Exhibit Hall, Cleveland Public Auditorium, during the 1952 Iron and Steel Exposition.

Lee Wilson

ENGINEERING Co., Inc.

20005 WEST LAKE ROAD • CLEVELAND, OHIO
Telephone ED-1-6600

LINTERN Aire-Rectifiers Proved On Soaking Pit Cranes Throughout the Past Decade



It is generally agreed that the toughest crane cab to air condition is that of a soaking pit crane. The Lintern Split System is particularly effective on this type of crane since it allows the condenser unit to be located high on the trolley where it is completely protected from direct radiant heat. Inasmuch as air ducts are not required, high efficiency is maintained and installation greatly simplified.

Send for complete information on the Lintern Aire-Rectifier. Or, better still, see this unit and the *new developments*—Booths 1 and 2—at the Iron & Steel Exposition.

THE LINTERN CORPORATION
P. O. Box 428 PAINESVILLE, OHIO

been appointed to the plant managership of the entire St. Marys, Pa., manufacturing facilities of Speer Carbon Co.

Archie M. Naysmith has been appointed general superintendent and plant engineer of Macwhyte Co., Kenosha, Wisc. Mr. Naysmith was formerly plant engineer.

Paul G. Mayer was appointed assistant to the vice president in charge of sales for Hydropress, Inc. Mr. Mayer has been active in the engineering, project and sales divisions of Hydropress and Loewy Rolling Mill Division for over 17 years.

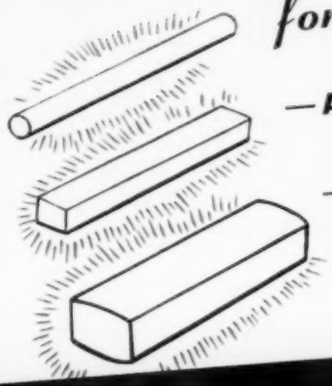
E. J. Lickwar was named sales representative in the Pittsburgh, Pa., area for Alloy Steel Products Co., Inc. Mr. Lickwar replaces in this capacity **Herbert V. Evans, Jr.**, who was recently made district manager for the company at Wilmington, Del.

John R. Gilmartin was named general sales manager of the Hyatt bearings division of General Motors Corp. in Harrison, N. J. Mr. Gilmartin succeeds **Howard K. Porter** who has been named assistant to general manager on special assignments. Mr. Gilmartin joined the Hyatt bearings division in 1929 in Detroit, Mich. There he was first associated with the engineering department and subsequently became a sales engineer before his transfer to the Hyatt home office in 1941. At Harrison he assumed charge of all Government contracts and priorities and later served as assistant production

JOHN R. GILMARTIN

manager until 1947 at which time he was appointed assistant to the general sales manager. Mr. Porter joined the Hyatt bearings division in 1916 and during the years held various engineering and sales positions at Harrison. In 1926 he became assistant general Sales manager and in 1930 was made general sales manager.

Roger M. Blough, vice chairman of the board, was elected a director of the U. S. Steel Corp. and a member of its finance committee. Mr. Blough became vice chairman of the board on May 6.

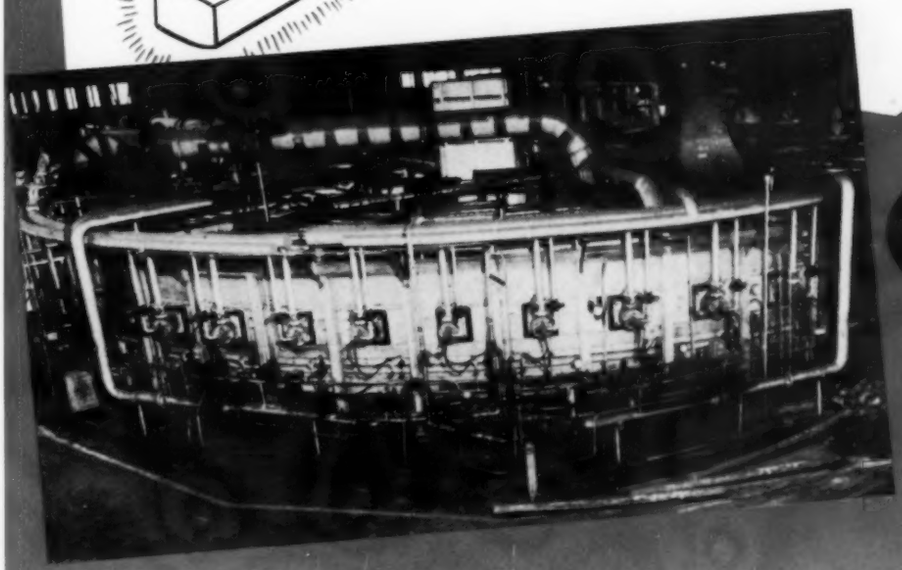


for **HEATING BARS—BILLETS—BLOOMS**

—AUTOMATIC CONTROL OF COMPLETE HEATING CYCLE

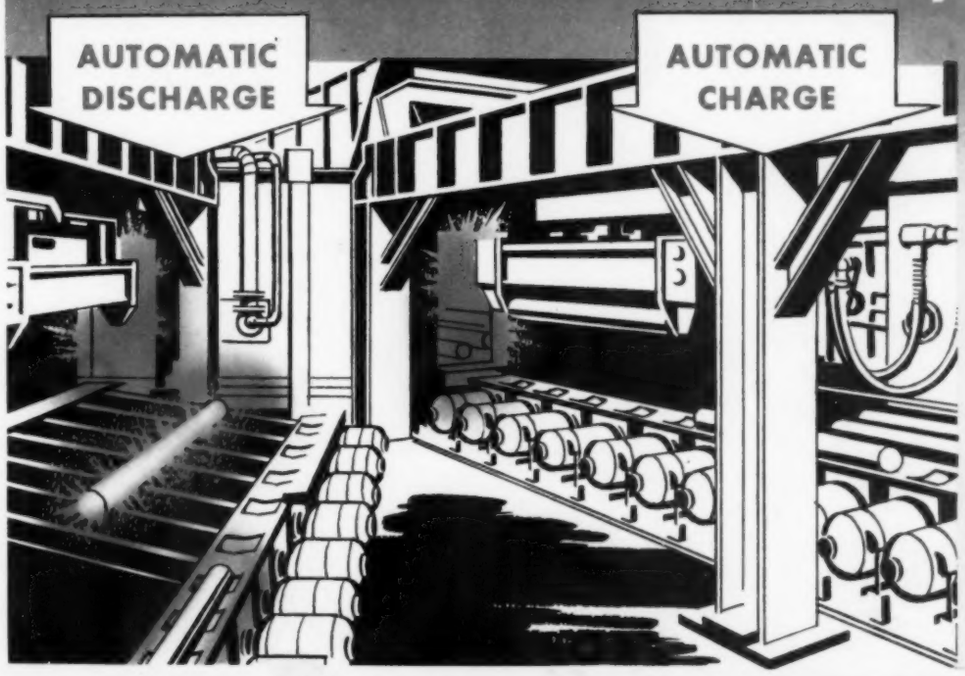
—AUTOMATIC CHARGING AND DISCHARGING

—FUEL SAVINGS UP TO 36%



Hagan

ROTARY HEARTH FURNACES



HAGAN Modern Firing Methods promote greater uniformity, produce less scale and give lower fuel consumption.

HAGAN Charger and Discharger grips stock endwise, giving greater hearth coverage and greater tonnage from a given furnace size. Grips can be adjusted within a minute for changes in length.

HAGAN Station Switch permits automatic charging of new stock on different heating cycle while stock is still being unloaded on previous setting, thereby decreasing mill delay.

HAGAN Rotary's completely automatic operation permits constant duplication of heating patterns, producing maximum yield with minimum heating cost.

I Check First with Hagan FOR ADVANCED ENGINEERING IN INDUSTRIAL FURNACE APPLICATIONS

GEORGE J. HAGAN COMPANY

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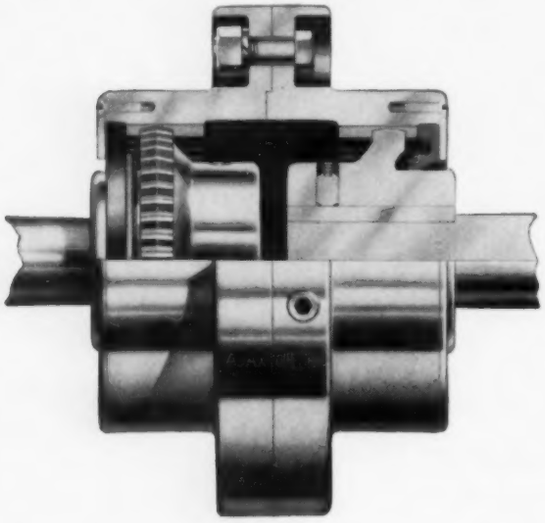
AJAX DIHEDRAL

FLEXIBLE COUPLINGS
Provide for and
Protect Against Excessive
MISALIGNMENT



▶ Mill service breaks the heart of men who use ordinary couplings. Ajax Dihedral Couplings are saving thousands of hours and dollars by eliminating the necessity for precision alignment of motors and other equipment. Change-overs made in minutes instead of hours.

Stock couplings delivered off the shelf to handle misalignment up to 4 degrees. 6, 8, 10 and 12 degree couplings cut to order.

Write for the facts,—experienced coupling specialists in the field give personal service.

AJAX FLEXIBLE COUPLING CO. INC.
WESTFIELD, NEW YORK

M. L. Cramer was appointed assistant sales manager of Eriez Manufacturing Co., Erie, Pa. Mr. Cramer came to Eriez from the Goodyear Rubber Co. in 1949. Since that time, he has acted as head of the sales engineering section.

L. F. Worden was appointed manager of sales—machinery manufacturers for General Electric Co. in Pittsburgh, Pa. In the Pittsburgh office, **E. A. Neish** was named manager of sales—electric utilities and transportation. **T. M. Lukens** was also named manager of sales—industrial.

L. F. WORDEN

Addition of four engineers to the Cleveland, New York, Buffalo, and Chicago district sales offices respectively of the Reliance Electric & Engineering Co. has recently been announced. These engineers, who already have taken over their new assignments, are: **James McCrea Biggar,** Cleveland, Ohio district sales office; **Burton B. Finigan,** New York, N. Y., district sales office; **Walter A. Jensen,** who goes to the Buffalo, N. Y., district sales office; and **William C. Prettyman,** to the central western district sales office in Chicago, Ill.

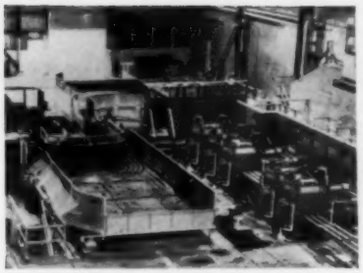
Henry Dreyfuss, industrial designer, has been retained by American Machine & Foundry Co., New York, N. Y., as design consultant.

Albert W. Boegner was appointed purchasing agent for the new Colmar, Pa., plant of Link-Belt Co. and **F. Walter Skerrett** was named to succeed him as purchasing agent of the Philadelphia, Pa., plant. Since 1950 Mr. Skerrett has been supervisor of the cost estimating department.

W. Roy Widdoes, director of industrial relations at Lukens Steel Co., Coatesville, Pa., since 1949, has been appointed to the president's staff. Mr. Widdoes will be secretary of the management committee, and will also take charge of certain vital phases of future planning for the company. **William C. Robinson,** currently assistant director of industrial relations, becomes acting director succeeding Mr. Widdoes.

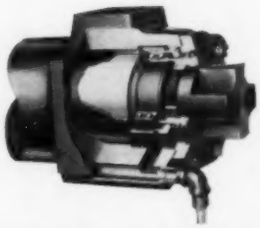
geared

TO HELP YOU PRODUCE MORE STEEL PRODUCTS



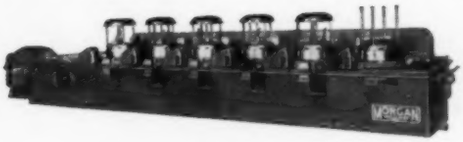
Continuous Rolling Mills

. . . built by specialists with over 60 years of pioneering in the field.



Morgoil Roll Neck Bearings

. . . will increase the accuracy of your product and save on operating and maintenance costs.

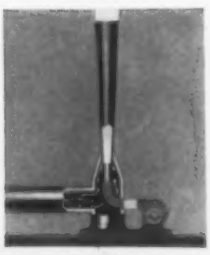


Wire Machines

. . . Morgan-Connors give high production, with low die cost, low power cost, low space requirement.

Furnace Control System

. . . Morgan-Isley increases efficiency of any regenerative furnace at relatively low installed cost.



Morgan Ejectors

. . . efficiently handle hot gases and fumes as high as 3000° F.

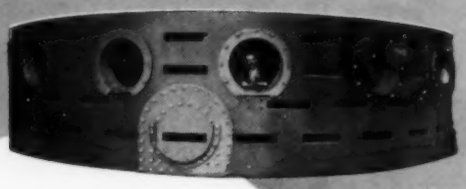
MORGAN WORCESTER

MORGAN CONSTRUCTION CO.
WORCESTER, MASSACHUSETTS

English Representative: International Construction Company
56 Kingsway, London, W. C. 2, England

RM-42

Furnace top ring, cone and platform.



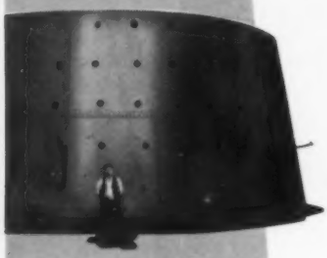
Tuyere jacket

"STANDARD BOILER"

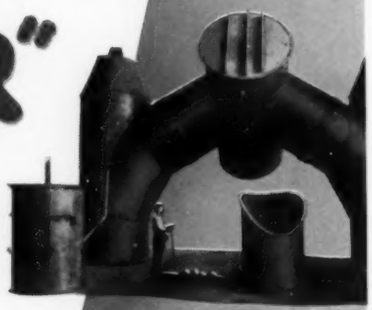
Industry's Headquarters for *Dependable*

STEEL MILL FURNACE CONSTRUCTION AND FABRICATION

for over 40 years!



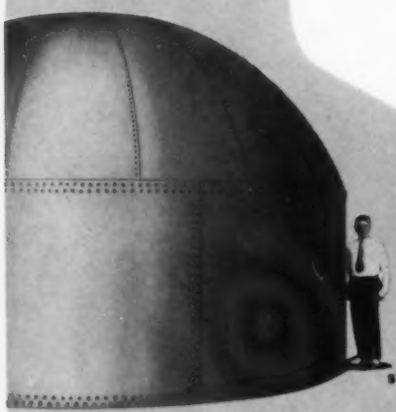
Furnace mantle and first two rings of shell



Uptakes and downcomer connection.

Assembled stove bottom.

Furnace top cone and off-takes



Hot blast stove dome.

Bustle pipe and platform.

STANDARD BOILER & PLATE IRON COMPANY

C. A. BRASSERT, *President*

ENGINEERS
FABRICATORS
ERECTORS

Offices: 210 Boulevard of the Allies
Pittsburgh 22, Pa.
SHOPS at NILES, OHIO

Glen McDowell has been appointed to the position of sales manager of Lewis Rolls division of Blaw-Knox Co. Mr. McDowell succeeds **J. M. Lewis,** who, after 32 years in roll sales, has been made assistant to Dr. F. H. Allison, Jr. **F. H. Frey** is serving as sales manager of the Pittsburgh Rolls division. This newly integrated roll sales organization will serve the rolling mill industries through the facilities of two Blaw-Knox roll-making divisions that have been completely modernized and substantially expanded during the past several years.

GLEN McDOWELL

George O. Manifold, professor of mechanical engineering at the University of Pittsburgh, has been appointed director of education of Hagan Corp., Pittsburgh, Pa. In announcing the appointment R. R. Donaldson, Hagan vice president, said the new Hagan program of education formalizes a long-established practice—special courses of study not only for Hagan personnel but also for other engineers sent to Hagan offices and plants in Pittsburgh and at Orrville, Ohio for study of Hagan combustion and process control systems, ring balance meters, and other equipment.

J. M. LEWIS

LOWER MAINTENANCE

another reason why
OHIO is the *PREMIER* mill magnet

In handling scrap, pigs, ingots—or in any mill application where magnets are subjected to severe blows—you need the extra structural strength of Ohio Magnets.

For example, take this rugged Ohio Protecto-Weld Magnet. The outer ring is a single hefty casting welded to the top plate. This means the weld is on *top* where it can't get dented in. Add to this Ohio's heavy-duty copper strip coils wound in long-lasting insulation and sealed with non-cracking asphaltum.

No wonder Ohio Magnets require less maintenance. So for extra magnet life, extra magnet value—specify Ohio Magnets. And remember, *Ohio Magnets lift as much or more than other magnets of the same size.* A-5718

THE OHIO ELECTRIC MFG. CO. • 5900 MAURICE AVENUE • CLEVELAND, OHIO

CHESTER BLAND
President

Ohio ELECTRIC

PUT UP TO STAY UP!

That's the statement of a midwest steel mill. Their letter continues: "We have in service GRID Unit Heaters Type No. 2500. A number have been in use for approximately 18 years on very severe service with steam turned on and off rapidly several times each day. Even under this severe service we have found them maintenance-free." There's the word of a mill operator who has proved that, with a GRID installation, first cost is last cost. Such service records (GRID installations made in 1929 are still operating) are the rule rather than the exception with GRID Unit Heaters because—

GRID is an all cast unit with finned heating sections and headers tested to withstand steam pressures up to 250# P.S.I.

GRID construction uses no brazed, soldered, rolled or welded connections between condenser and headers. A specially designed threaded nipple assures a precision, leakproof fit.

GRID construction has all similar metals in contact with steam thus preventing electrolytic corrosion which eventually occurs in copper type unit heaters where steam passes from iron pipes into copper cores. (Write for booklet CORROSION IN UNIT HEATERS).

GRID construction resists corrosion from corrosive acid fumes that exist in most steel mills.

GRID design incorporating low outlet temperatures, proper fan sizes and motor speeds, assures delivery of warm comfortable air in ample volume to the working level. No stratification of warm air at the ceiling to waste your fuel dollars.

EASTERN STAINLESS STEEL CORP. USES GRID BLAST COILS FOR SHEET DRYING. WRITE FOR CATALOG BC-1049.

These are the reasons why steel mill operators get 18 years and more of trouble-free service. There are units cheaper than GRID, but there is none better.

You start saving money the day you install GRID Unit Heaters. Get the complete GRID story. Write for catalog CUH-846-A.

REPRENTATIVES IN PRINCIPAL CITIES

D. J. MURRAY MANUFACTURING CO.

MANUFACTURERS SINCE 1883

WAUSAU, WISCONSIN

Hagan engineers will serve as instructors. Classes will be held in the new Laboratories at Orrville, Ohio.

Charles R. Gordon was appointed general superintendent of machine shops at the Midvale Co., Nicetown, Philadelphia, Pa. **Joseph B. Larkins** was named assistant director of industrial relations. **John P. Mudd** becomes manager of public relations.

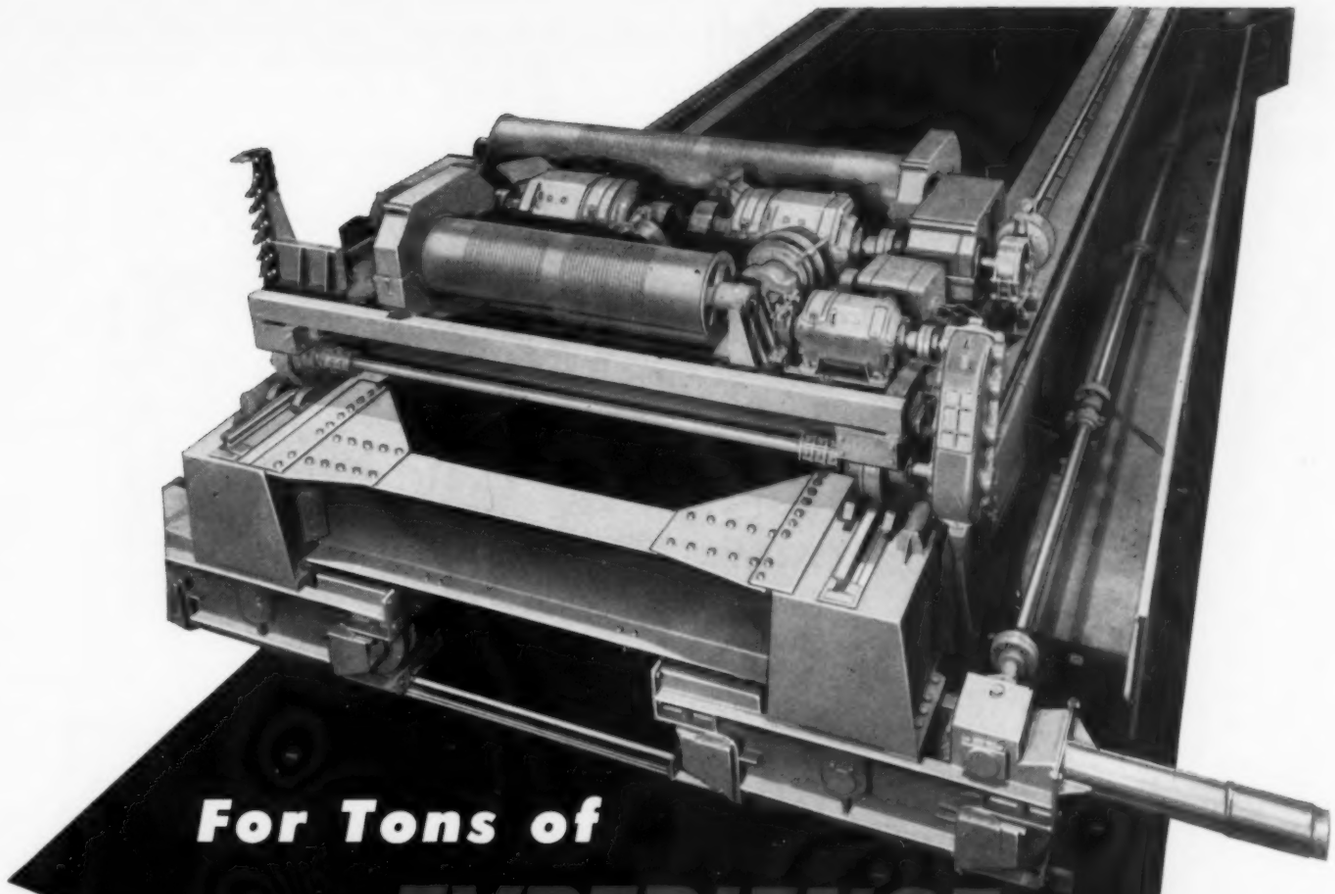
Robert Whitehill, who has been with the Clark Controller Co. 15 years in sales work in Boston, Mass., New York, N. Y., and Pittsburgh, Pa., areas, and has served as Cleveland, Ohio, district manager since

ROBERT WHITEHILL

September 1, 1950, becomes assistant general sales manager. **John D. Puette,** district engineer in the Cleveland district sales office since September 1, 1950 has been appointed Cleveland district manager. **L. H. McClure** since September 1, 1944 manager of

JOHN D. PUETTE

merchandising and export sales in the home office takes on the additional duties of manager of marketing, with **W. J. Bergen** as Assistant manager of merchandising. **S. S. Siegel** is in charge of advertising and sales promotion in the marketing department. **W. R. Heckman** moves to the Cleveland district sales office from the Akron office to the district application engineer, and **W. J. Backus,** formerly of the Cincinnati office replaces him in Akron. **W. A. Krueger** replaces Mr. Bergen to handle merchandising sales in the Cleveland district.



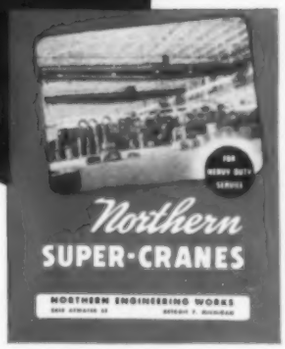
For Tons of EXPERIENCE

53 Years

When you install a Northern Overhead Electric Traveling Crane or heavy duty Hi-Lift Hoist you are utilizing the full benefit of our 53 years experience as crane builders for many of the most efficiently operated and competitive companies in American industry.

One of these companies has installed over 700 Northern Cranes in its many plants for a wide range of material handling usage — adding up to an amazing tonnage in capacity, and in experience!

It takes the best experience available to tool properly to remain competitive today. Northern Cranes can safely assure you a satisfactory, dependable, long-term tooling investment based on tested, seasoned experience.



Write for new Super-Crane Bulletin No. SE-108-161 for information and major specification details of Northern Super-Cranes and Super-Trolleys.

NORTHERN ENGINEERING WORKS

General Offices: 2615 Atwater St., Detroit 7, Michigan

BUILDERS OF CRANES AND HOISTS EXCLUSIVELY

Why you can place full confidence in BOILER FEED PUMPS *by* Pacific

IT'S A MATTER OF RECORD

That the availability for service of your boiler feed pump and the cost of maintaining it in top condition is determined by design . . . workmanship and materials of construction.

IT'S A MATTER OF RECORD

Pacific's designs provide the balanced proportions that insure mechanical strength . . . the simplicity of form that insures hydraulic efficiency . . . material efficiency . . . easy maintenance.

IT'S A MATTER OF RECORD

Pacific's precision workmanship provides . . . metal-to-metal sealing of internal joints to prevent water jetting from a high to a low pressure area . . . truly concentric shaft sleeves . . . close sliding fits, making it unnecessary to "shrink" impellers on the pump shaft.

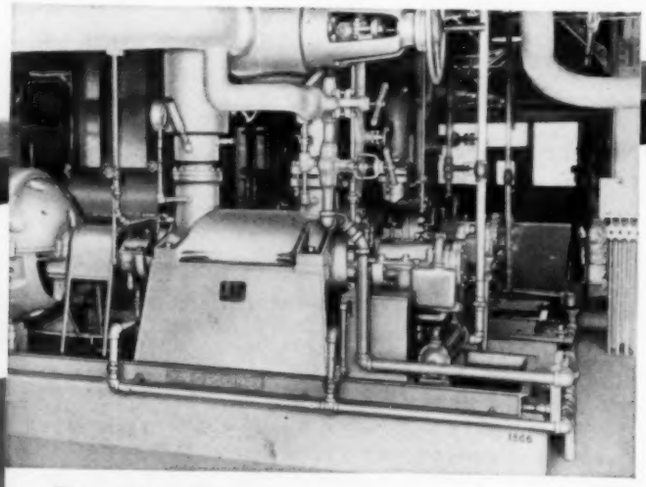
IT'S A MATTER OF RECORD

Pacific Boiler Feed Pumps are fabricated from materials carefully selected for specific functions . . . steel forgings for structural strength and stability . . . alloy steels for hardness . . . resistance to wear and to corrosion-erosion.

IT'S A MATTER OF RECORD

Pacific Multi-Stage Boiler Feed Pumps are built for capacities to 2700 G.P.M. . . . Discharge Pressure to 3000 psig . . . speeds to 5000 R.P.M. . . . Bulletin 109 for details.

Pacific Single Stage TURBOPUMPS are built for capacities to 1000 G.P.M. . . . Discharge Pressures to 1800 psig . . . Speeds to 10,000 R.P.M. . . . Bulletin 118 for details.



PACIFIC *Precision Built* PUMPS

BF-10

Pacific Pumps inc.

ONE OF THE DRESSER INDUSTRIES

HUNTINGTON PARK, CALIFORNIA

Export Office: Chanin Bldg., 122 E. 42nd St., New York ★ *Offices in All Principal Cities*

Howard F. Martin, for the past two years operation consultant in the office of the executive vice president—production, Jones & Laughlin Steel Corp., has retired.

HOWARD F. MARTIN

Mr. Martin's retirement brought to a close a career of 28 years with Jones & Laughlin in which time he rose from a foreman's job in the electrical department to the top position of general superintendent of the Aliquippa, Pa. plant.

Clarence N. White has been appointed to the sales engineering staff of Fred R. Ramsen & Associates, St. Louis, Mo., area distributor for the Baker-Raulang Co.

John A. Cortelli has been elected vice president of Clark Controller Co., Cleveland, Ohio. His assigned duties will be vice president—engineering, and chief

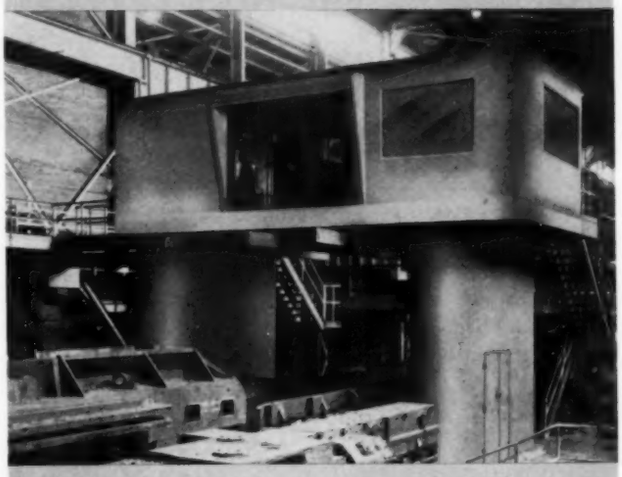
JOHN A. CORTELLI

engineer. Mr. Cortelli has been serving as chief engineer since March, 1946.

M. C. Nelson was named vice president and director of the Barksdale Valves, Inc., Los Angeles, Calif. Mr. Nelson was formerly general manager.

William J. Henry has been named manager of the

MODERN MILL OPERATOR'S PULPIT



QUIET COMFORTABLE SAFE

MODERN MILL OPERATOR'S PULPIT FOR NEW MILLS AND REPLACEMENT IN EXISTING MILLS

WHERE USED: Ingot Buggies; Main Rolling Mills; Billet and Slabbing Mills, Furnaces, Roughing Mills, Coil Handling; Instrument Rooms; Mill Offices; and Crane Cabs.

100% INSULATED AND FIREPROOF · INDIRECT LIGHTING · CONCEALED WIRING · SHIPPED COMPLETELY ASSEMBLED · INSTALLATION A MATTER OF HOURS · AIR-CONDITIONED · SAFETY GLASS

JAMES CAMPBELL SMITH, INC. ENGINEERS AND FABRICATORS OF INDUSTRIAL EQUIPMENT

4057 ERIE STREET · WILLOUGHBY, OHIO · WILLOUGHBY 2-1300

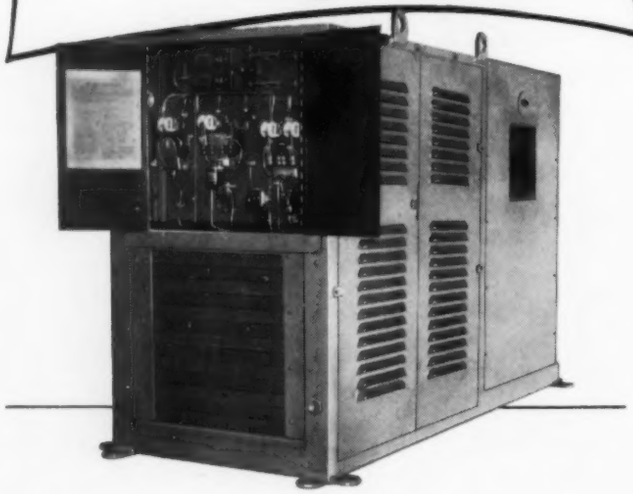
Cleveland 15, Ohio, 1900 Euclid Avenue
Phone: Main 1-1878

St. Louis, Mo., 221 Fullerton Building
Phone: Chestnut 9000

Temple, Tex., 1119 N. Third Street
Phone: Temple 7126

INDUSTRIAL OVENS · MINERAL WOOL EQUIPMENT · SPECIAL PRODUCTION EQUIPMENT

Only—DRAVO
CRANE CAB COOLERS and CONDITIONERS
HAVE THESE 6 EXCLUSIVE FEATURES



HERE ARE THE *PLUS* ADVANTAGES THAT DRAVO CRANE CAB COOLERS AND CONDITIONERS OFFER YOU—

1. **COOL AND CLEAN AIR SUPPLY.** All self-contained and split-type Dravo Crane Cab Coolers are equipped with a forced-ventilation system, insuring a supply of cool air free from dust and fumes to the compressor motor.

2. **RUGGED CONSTRUCTION.** Dravo Crane Cab Coolers and Conditioners are supported by a structural steel frame of all-welded construction.

3. **MAXIMUM VOLUME OF AIR.** All units are equipped with centrifugal-type squirrel-cage fans which furnish maximum amount of air.

4. **HIGH EFFICIENCY.** Condenser discharge air exhausts directly into atmosphere, permitting lower operating temperatures within condenser section.

5. **CONTROL PROTECTION.** Heavy-duty industrial controls are enclosed in a forced-ventilation cabinet, free from dust and fumes.

6. **COMPLETE LINE OF EQUIPMENT.** Only Dravo has a complete line of crane cab coolers and conditioners. Interchangeable parts reduce inventory costs.

Dravo Crane Cab Coolers and Conditioners protect crane cab operators' health, increase their efficiency and alertness, insure safety and improve production records . . . they provide complete air conditioning, filter the air, remove dusts, dirt and fumes; heat the cab in winter, cool it in summer, provide constant ventilation the year around.

AVAILABLE FOR PROMPT DELIVERY. Installation of Crane Cab Coolers and Conditioners is quick and easy with a minimum of downtime required. Write for more information, or phone the nearest Dravo sales office and have our representative call on you.

DRAVO CORPORATION

602 Dravo Building, Fifth and Liberty Avenues, Pittsburgh 22, Pa.

VISIT BOOTHS 230, 231 AND 232

at the Annual Convention and Iron and Steel Exposition, Cleveland, Ohio

Homewood manufacturing and repair plant of the Westinghouse Electric Corp. in Pittsburgh, Pa. Mr. Henry succeeds **John H. Thomas** who recently was appointed manager of manufacturing at the firm's East Springfield, Mass. plant. As head of the Homewood plant, Mr. Henry will direct the operation of one of the most important phases of Westinghouse service to industrial customers in the area—that of repairing and maintaining industrial equipment.

W. C. Berg, Jr., has joined Continental Foundry & Machine Co., in the capacity of sales engineer. Formerly eastern division sales manager of Laclede-Christy Co., Mr. Berg served prior to that as a sales engineer in the industrial sales department of Gulf Oil Corp.

W. C. BERG, JR.

John Deaderick was named manager of the Philadelphia, Pa. office of Foxboro Co. at 1621 Chestnut Street, serving the industrial sections of eastern Pennsylvania and southern New Jersey. **Joseph Esherick,** well known in industrial circles through his many years as district representative of Foxboro in Philadelphia, now devotes his entire attention to special accounts, serving as manager of that department. Mr. Deaderick previously served as industrial engineer at Foxboro branches in Corpus Christi, Tex., and Baton Rouge, La., and as manager of the Tulsa, Okla., branch.

G. T. Van Alstyne has been appointed director of advertising and publicity of Air Reduction Co., Inc. **George M. Worden,** recently with Hill and Knowlton, Inc., public relations counsel, rejoins the company as assistant to the director. Mr. Van Alstyne is succeeded as advertising manager of Air Reduction Sales Co. by **A. V. Scherer,** formerly advertising manager of the Ohio Chemical & Surgical Equipment Co. division. Mr. Scherer is succeeded at Ohio Chemical by **Henry W. Beck.** The men involved will have their headquarters in New York with the exception of Mr. Beck, who will be located at Madison, Wisc.

John K. Byrne has opened offices at 540 N. Michigan Ave., Chicago, Ill., where he will serve as a manufacturers' representative. Mr. Byrne was formerly sales manager of the Complete Reading Electric Co. of Chicago.

PRODUCING AGAIN...
13 HOURS SAVED

Powder-lancing pierces

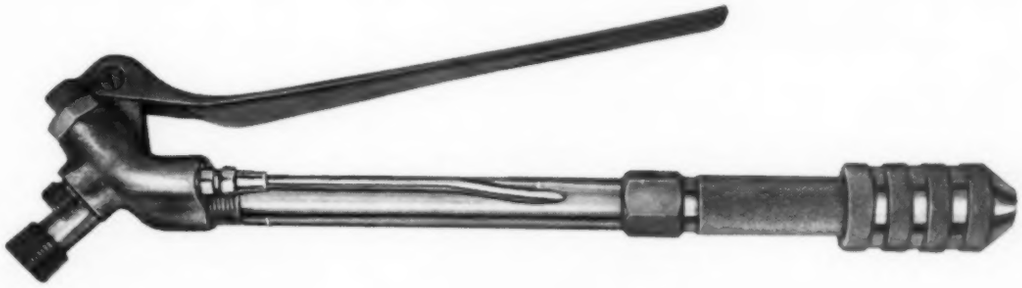
blast-furnace salamander in only ½ **hour**

That's just one case. Other steel mills have gone back into production just as quickly—thanks to the efficient use of powder-lancing.

Powder-lancing is a new idea for increasing the efficiency of oxygen lance operations. By introducing powder into the oxygen stream, an exothermic reaction results producing extremely high temperatures. Holes are easily pierced not only in salamanders, but in concrete, cinder block, fire brick, aluminum, and other materials at speeds up to 11 in. per minute. And lance pipe needs no threading. A twist seals it into the holder.

LINDE'S ACL-1 Powder Lance automatically adds to the oxygen stream the correct amount of powder for best results. For further details, telephone or write today. LINDE AIR PRODUCTS COMPANY, a Division of Union Carbide and Carbon Corporation, 30 East 42nd Street, New York 17, N. Y. In Canada: Dominion Oxygen Company, Limited, Toronto.

LINDE'S ACL-1 Powder Lance can be used with any standard pipe.



LOOK TO *Linde* Trade-Mark **know-how . . . show-how . . . products and processes FOR WELDING, CUTTING, TREATING, FORMING METALS**

The term "Linde" is a registered trade-mark of Union Carbide and Carbon Corporation.

John I. Somers was appointed sales manager for "Worksaver" electrically-operated hand lift trucks, manufactured by Yale and Towne Mfg. Co., Philadelphia, Pa. **T. F. Moriarty** was named sales manager for manually-operated hand lift trucks.

Paul W. Pheneger was named general superintendent of Superior Steel Corp.'s ordnance clad metal plant

PAUL W. PHENEGER

at Carnegie, Pa. and **J. Herbert Morgan** was appointed general purchasing agent. Formerly assistant to the president and purchasing agent of Superior Steel, Mr. Pheneger will supervise the completion and direct the operation of the new five million dollar rolling mill, which is being built by Superior and equipped by Army Ordnance. The mill will be used for the manufacture of copper and brass clad metals for defense.

William Rogers Herod has been elected a vice president of the General Electric Co. and will continue as president of the International General Electric Co.,

J. HERBERT MORGAN

which he has headed since 1945. At the same time it was announced that the International General Electric Co., Inc., which has been a wholly owned affiliate of General Electric since 1919, will, on July 31, be merged with and become a division of the General Electric Co.

when you CHANGE over to SPRAYING SYSTEMS descaling NOZZLES

If you want to materially reduce down time on rolling mills due to clogged nozzles, try Spraying Systems descaling nozzles. Large orifice diameter permits passage of practically all particles that ordinarily clog other types of nozzles. Spraying Systems nozzles produce an effective uniform flat spray, free of streaks, with an impinging force equal to over 96% of the maximum potential. Typical user is the Homestead District Works of U. S. Steel illustrated above. Nozzles are made of hardened stainless steel in a wide range of capacities and spray angles. Your inquiry is invited . . . write for Data Sheet 3997.

SPRAYING SYSTEMS CO.
3262 RANDOLPH STREET • BELLWOOD, ILLINOIS

Also write for Data Sheet 4516 . . . Pneumatic Atomizing Nozzles for direct spray gear lubrication.

for custom-engineered POWER look to... EP

• Since 1909, our job has been to create and develop special electrical rotating equipment. This specialization assures equipment designed and built to your exact requirements... guarantees greater dependability, longer life, less maintenance.

Return coupon for information on our Custom-Engineered a-c and d-c motors and generators . . . induction motors . . . battery chargers . . . frequency changers.

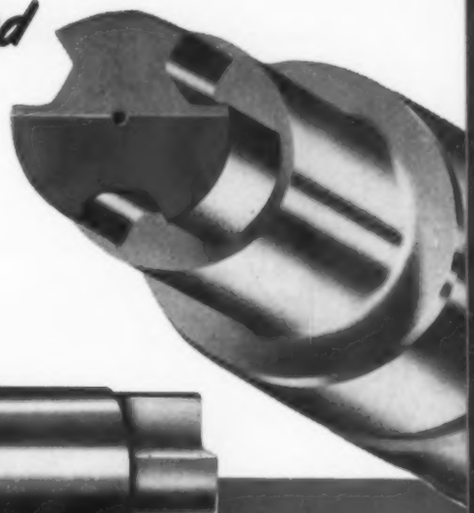
Our nation-wide sales engineering and service organization stands ready to meet all User requirements.

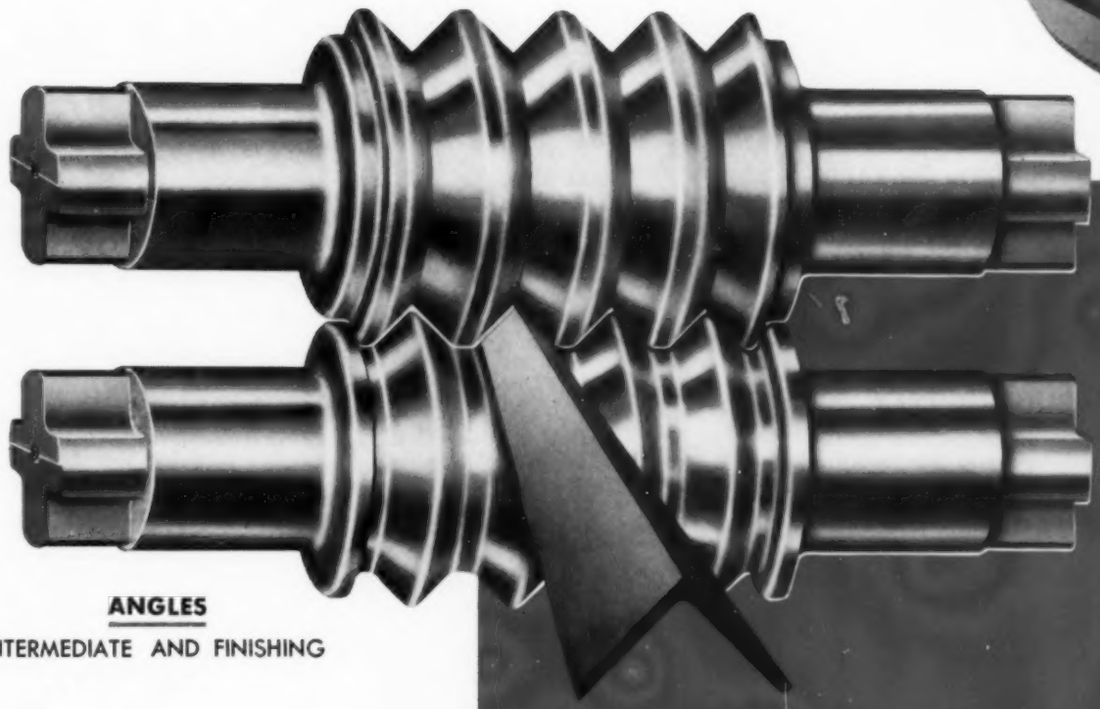
THE ELECTRIC PRODUCTS CO.
1718 CLARKSTONE ROAD
CLEVELAND 12, OHIO

Attach coupon to your letterhead for your copy of Bulletin 2-200.

NAME_____
TITLE_____
COMPANY_____
STREET_____
X-75 CITY_____ ZONE_____ STATE_____

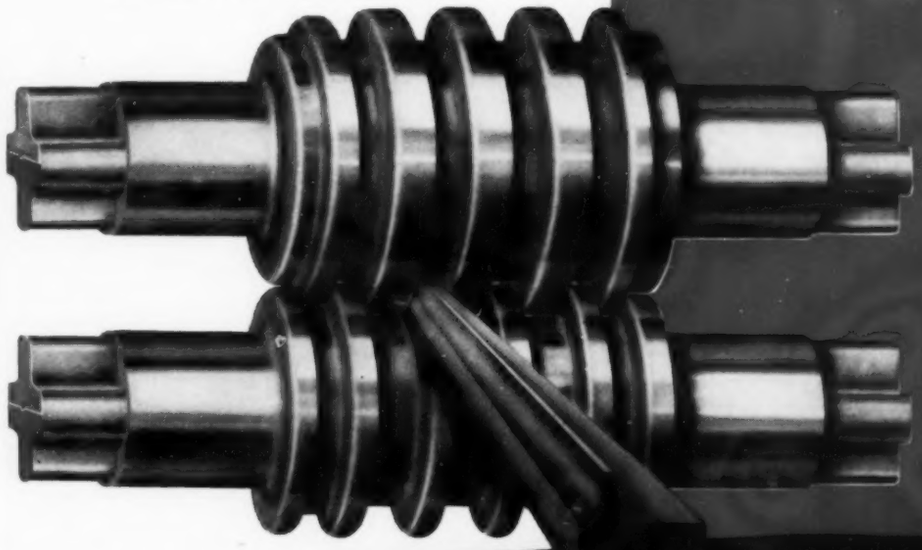
PHOENIX "K" ROLLS are color marked for specific uses in rolling . . .





ANGLES
INTERMEDIATE AND FINISHING

SPECIAL SHAPES
INTERMEDIATE AND FINISHING



OTHER PITTSBURGH ROLL TYPES

Chill
Moly Chill
Special Rail Finishing
Pittsburgh Grade 25
Pittsburgh Grade 35
Pittsburgh Grade 45
Pittsburgh Grade 55
Pittsburgh Grade Special Process
Phoenixloy
Phoenix Metal
Phoenix Metal Matter
Phoenix "A" Alloy Steel
Phoenix "A" Special Alloy Steel
Carbon Steel

P.R.W.

PITTSBURGH ROLLS

PITTSBURGH ROLLS DIVISION of BLAW-KNOX COMPANY • PITTSBURGH, PA.

As a division of the parent company, the International Electric Co. will retain that name and continue to have the same responsibility for the conduct of the foreign business of the company. Mr. Herod and the other officers of the former affiliate will retain their titles and continue in the same capacities.

A. Callaway Allen was appointed sales manager of the electrical division of Wagner Electric Corp., St. Louis, Mo., to succeed **H. A. Hudson** who has a new position as sales analyst for the company. Mr. Allen has been serving as manager of the Wagner electrical sales branch at Memphis, Tenn.

A. CALLAWAY ALLEN

Sands G. Falk has been appointed manager of the new foundry and weldment sales division of Falk Corp., Milwaukee, Wisc. Handling weldment sales is **Dave P. Miller** who will also be active in casting sales on accounts that use both weldments and castings. **Steward C. Hagen** has transferred from the foundry operating division to the foundry and weldment sales division. He will concentrate chiefly on steel casting sales.

August R. Ryan, has been named manager of sales for furnaces and associated equipment of General Electric's industrial heating department.

Obituaries

John Schneider, 48, for 26 years a salesman for the Cleveland Electric Illuminating Co., in the industrial division, died July 14.

A. J. Frantz, 61, chief engineer, Armco International Corp., recently died in Italy.

Adam Lilly, superintendent of the mason department, Inland Steel Co., Indiana Harbor, Ind., died recently.

Gerald J. Weckmueller, assistant superintendent of blast furnaces, Inland Steel Co., Indiana Harbor, Ind., died recently.

ALWAYS READY TO SERVE STEEL PRODUCERS

IN spite of the best of operating practice, blast furnace copper casting and steel mill bronzes wear out and must be replaced and replaced QUICKLY!

Blast furnace and steel mill new construction projects require copper and bronze castings ON SCHEDULE.

Your experience has convinced you that *you can expect immediate* and *scheduled* deliveries of QUALITY copper and bronze castings from THE FALCON BRONZE COMPANY.

FALCON

COPPER
Valve Seats
Valve Gates
Inwall Plates
Bosh Plates
Tuyeres
Coolers
Monkeys
COPPER AND BRONZE CASTINGS

LICENSED MAKERS OF ALL PATENTED DESIGNS
DEPENDABLE FOR 62 YEARS • SINCE 1890

Telephone Collect 3-4186
FALCON BRONZE CO.
YOUNGSTOWN 3, OHIO
Established 1890 · Incorporated 1895

HAVE YOU HEARD ABOUT THIS NEW METAL CLEANER?
IT CAN SAVE MONEY FOR YOU
New metal cleaner removes oil and rust in one operation
OAKITE PRODUCTS, INC.

Oakite Compound No. 33 removes oil *at the same time* that it removes rust. And *at the same time,* it prepares metal for painting.

It's a great soak cleaner for steel, cast iron and aluminum; and great for hand-swabbing on metal surfaces too large to be soaked in tanks. *It frequently eliminates pickling operations on moderately rusty steel.*

FREE For a copy of Folder F7993 *"New metal cleaner removes oil and rust in one operation",* write to Oakite Products, Inc., 19 Rector St., New York 6, N. Y.

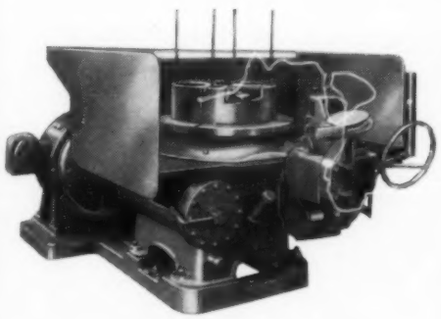
Technical Service Representatives in Principal Cities of U. S. & Canada

OAKITE SPECIALIZED INDUSTRIAL CLEANING MATERIALS • METHODS • SERVICE

From the finest wire →

to the largest bar

VAUGHN® Cold Drawing Equipment



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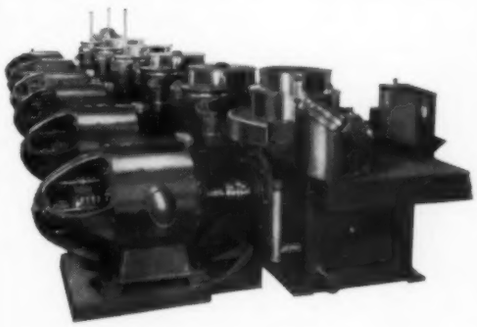

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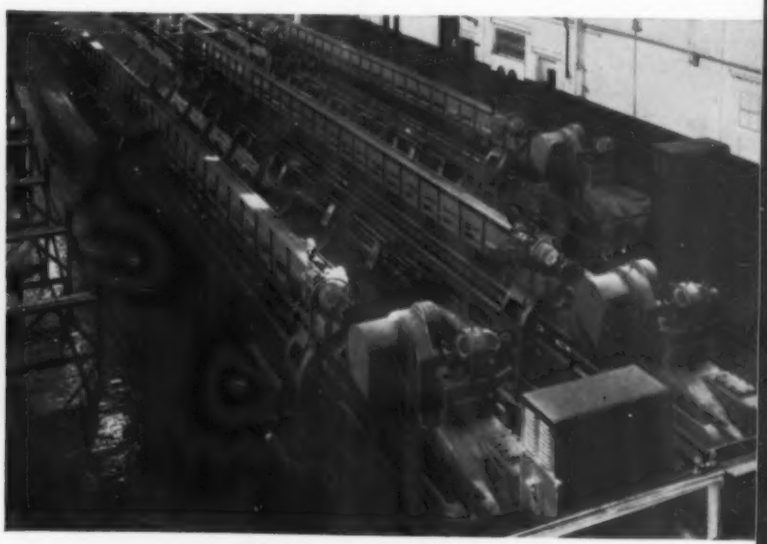
RINGBLOX®

CONTINUOUS MACHINES

DRAWBENCHES



V®

Whatever your cold-drawing requirements call for in production, you can be sure of finding Vaughn Machines that are *right* in type, size and capacity to do the job best, at lowest cost. Let our broad experience assist your planning—now!

"Quick on the Draw"

THE VAUGHN MACHINERY CO.

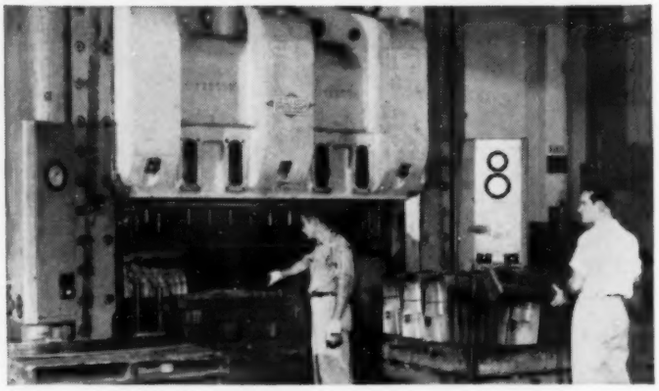
Cuyahoga Falls, Ohio, U.S.A.

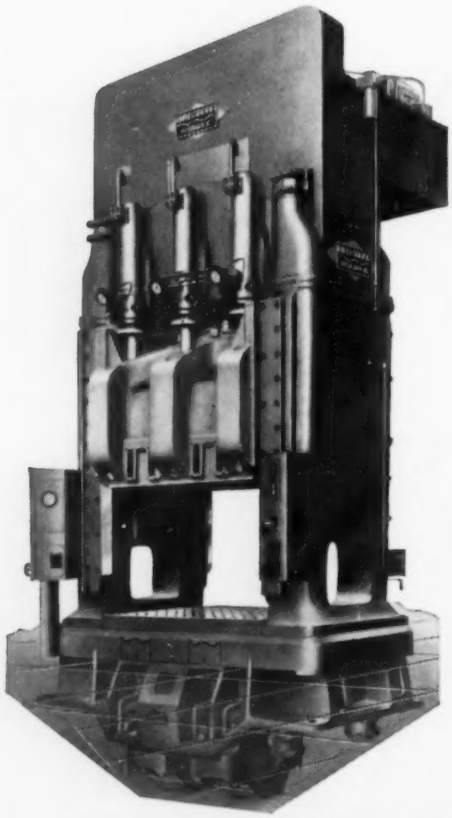
COMPLETE COLD DRAWING EQUIPMENT . . . Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.

BIRDSBORO HYDRAULIC

Look Behind This Trade-Mark for

ADVANCED ENGINEERING
HIGH PRODUCTION
TROUBLE-FREE OPERATION
in
Hydraulic Metalworking Presses





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STEEL FOUNDRY & MACHINE CO.
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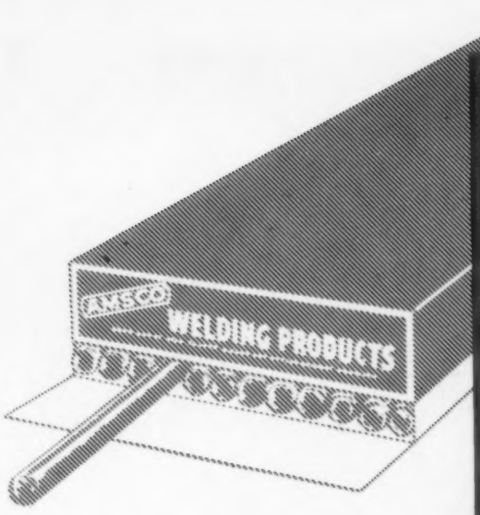

How AMSCOATING with Amsco Hardfacing Rods saves you materials . . . manpower . . . money.

Amscoating these guide shoes kicks tube production up

AMSCOATING . . . stands for control of wear by Hardfacing . . .

Hardfacing Rods—and recommendations for their use—are as sound as the manufacturer who makes them. AMSCO has been fighting wear for a half-century—first with Manganese Steel, and later with AMSCO Hardfacing Products.

If you have a problem of wear caused by impact, abrasion, heat or corrosion . . .

Find out how AMSCOATING can save you materials . . . manpower . . . money!

Continuous production, greater safety and better weldability are three good reasons for Amscoating Piercer Guide Shoes.

These Piercer Guide Shoes are used at a large midwestern steel plant to hold a rotating hot bar in alignment during the initial piercing operation. Wear was not the main problem here. The condition to be avoided was "pick-up", where the bar becomes fused with shoe and literally explodes.

To lick this problem, which can result in expensive equipment damage and loss of life, the welding superintendent chose Amsco Thermalloy No. 4 for three reasons:

1. **Complete elimination of pick-ups . . . for greater safety and higher production**
2. **Better weldability . . . Thermalloy No. 4 covers heat checks, prevents small cracks that can cause pick-ups or seizing.**
3. **Amscoated shoes can be used many times . . . for big savings in replacement costs over a year's period.**

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THE RIGHT WAY TO SAY HARDFACING

AMERICAN Brake Shoe COMPANY

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Amsco Welding Products distributed in Canada by Canadian Liquid Air Co., Ltd.

why CRANE 600-pound small steel gates are sure to meet your needs

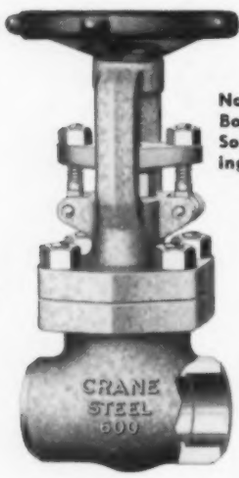
UNION BONNET GATE. Screwed ends. Sizes: ¼ to 2-inch. Available in three different trim materials for a wide range of services. Also with socket welding ends

You can't top these Crane Small Steel Gates for dependable performance on high pressure, high temperature lines . . . for ease of operation . . . for simplified maintenance. That's because they include design features normally found only in larger or more expensive valves.

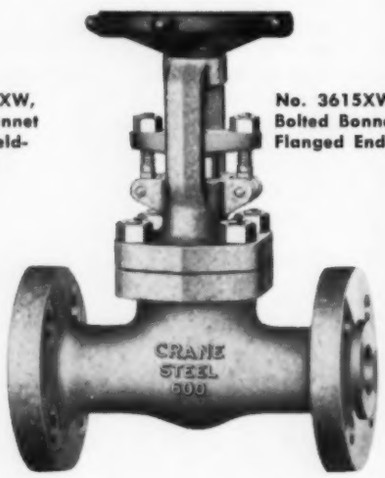
Then too, these Crane valves are available in a choice of types to meet your particular requirements. For example, with union or bolted bonnets; with screwed, flanged, or socket-welding ends; and in trim materials recommended for all common fluids.

GET NEW DESCRIPTIVE CIRCULAR AD-1881

For complete information—including prices—about these longer lasting, easier operating Crane Small Steel Gate Valves. Ask your Crane Representative for your copy, or write direct. No obligation.

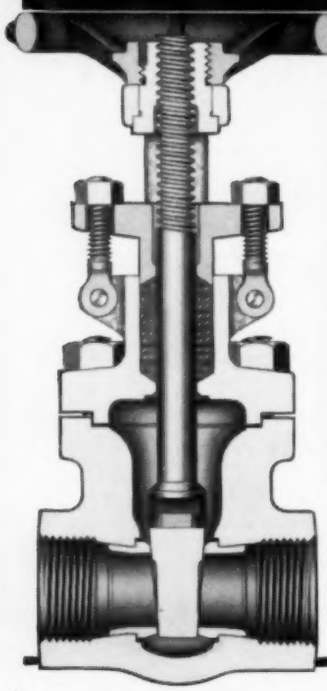


No. 3611XW, Bolted Bonnet Socket-Welding Ends



No. 3615XW, Bolted Bonnet Flanged Ends.

Easy to Operate... Easy to Service



EASY ACCESS to stuffing box assured by swinging gland eyebolts. Improved yoke design provides liberal working space.

DEEP STUFFING BOX filled with high quality asbestos packing rings maintains tight stem seal.

LEAKPROOF BONNET JOINT. Soft iron gasket in male and female joint cannot blow out.

T-HEAD DISC-STEM connection provides flexibility for smooth operation; prevents stem distortion or binding of parts.

Cross-section No. 3607XW, Bolted Bonnet Gate, Screwed

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VALVES • FITTINGS • PIPE • PLUMBING • HEATING

NOW . . . a *reinforced* slipper bearing
MADE OF A-B-K LAMINATED FABRIC

THE SECRET IS THIS LADDER

This bronze-manganese "ladder", molded in tough A-B-K Fabric, makes a reinforced bearing remarkable for its strength, durability and long life.

A-B-K MATERIAL . . . uniquely reinforced . . . gives remarkable bearing life, exceptional coupling protection

If your present slipper bearings break, wear excessively or need constant maintenance, change to this new A-B-K Bearing.

Made of A-B-K Laminated Fabric, it eliminates metal-to-metal contact. It protects coupling members, will not peen out or take a permanent set. The interlocking, reinforcing "ladder" enables it to withstand exceptionally severe shock loads and strains without splitting or breaking apart. Result: down time is reduced, tonnage is maintained, replacement and maintenance costs are minimized.

Investigate this new A-B-K Reinforced Slipper Bearing. Our engineers will be glad to recommend the right material formula for your specific use.

A-B-K Material Has Many Unusual Properties . . . exceptionally low coefficient of friction . . . highly resistant to shocks and strains . . . excellent structural strength . . . wears slowly and evenly . . . will not score or heat check metal parts . . . good dielectric qualities . . . can be machined to close tolerances . . . grease or water lubricated . . . available in eight different formulas.

If these characteristics suggest a use to you, either as a bearing or for some other component part, A-B-K Engineers will be glad to work with you in its development. Write for our free explanatory folder, today.

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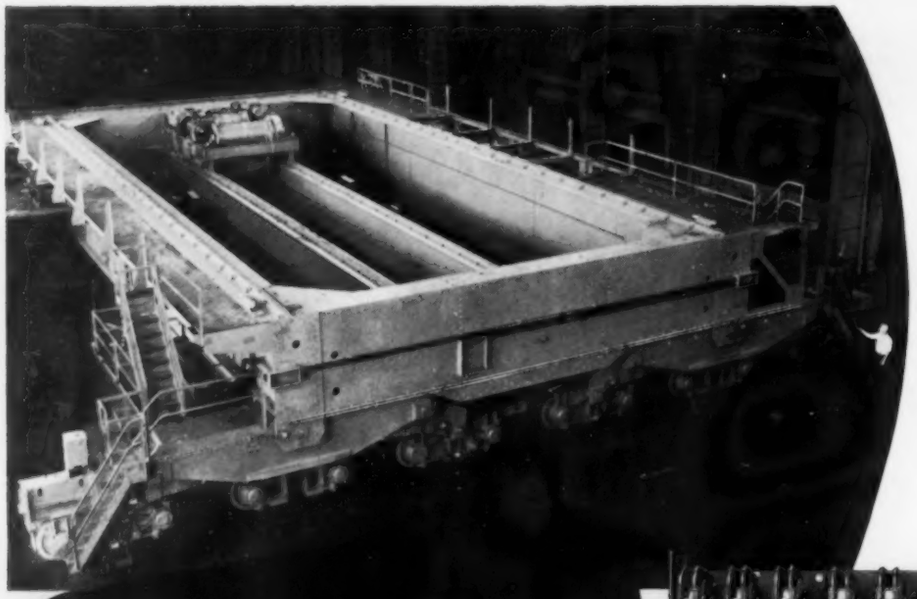
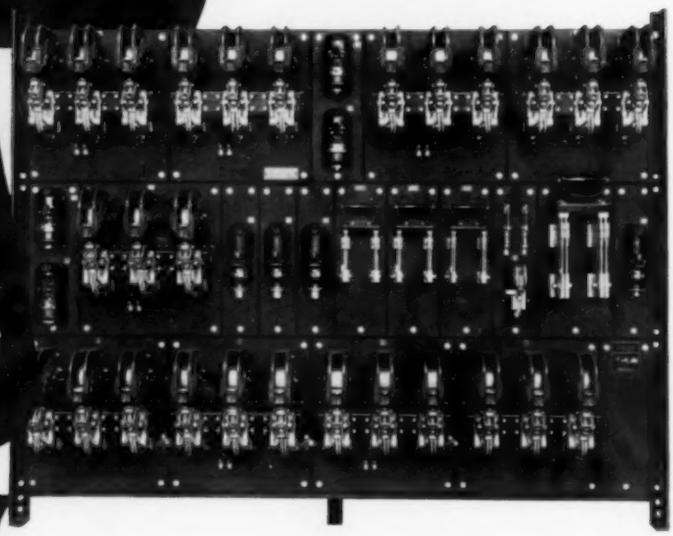


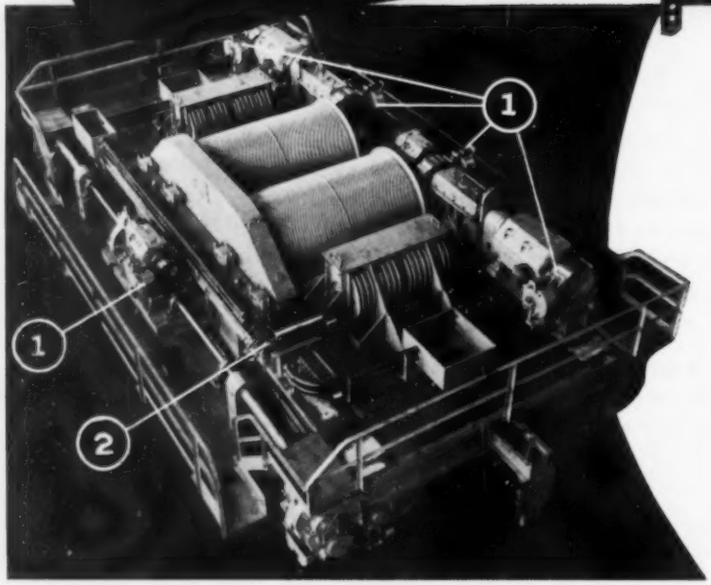
350-ton Ladle Crane on erection floor of Morgan Engineering Company.

6 MOTORS CONTROLLED AS 1

UNDER

EC&M TRIPLEX TIME-CURRENT Controller





The above EC&M Triplex Time-Current Controller controls 3 sets of motors in parallel, each set consisting of 2 motors connected in series. Uniform current peaks during starting, accelerating and plugging operations are maintained in each set of motors by this EC&M Method of Control.

The trolley for this crane (at left) is also EC&M equipped: Type WB Brakes (1) on the hoist and trolley motors, and EC&M Duplex Safety Hoist Stop (2) for the hoist motors.

When Buying Cranes It Pays To Specify EC&M Control

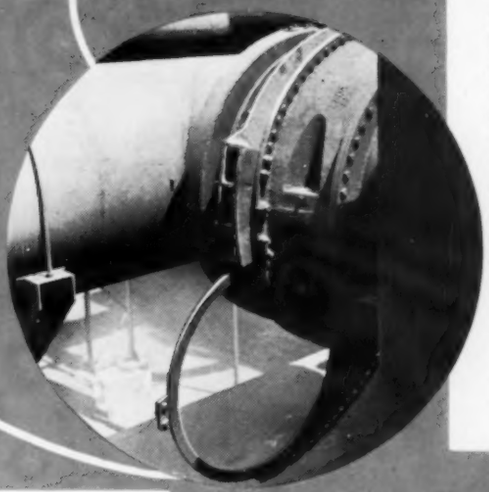
THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79TH STREET • CLEVELAND 4, OHIO

Bailey GOGGLE VALVES

THERMAL

MECHANICAL



Open & Close *Instantly*

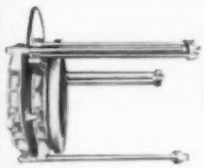
WHETHER OPERATION IS FREQUENT OR OCCASIONAL

THERMAL EXPANSION TYPE

Steam passing through steel tubes causes linear expansion sufficient to free the goggle plate. When the steam is removed, normal cooling contracts the tubes, clamping the goggle plate with a gas-tight seal. In case of steam failure this type Bailey Valve can be operated mechanically.

MECHANICAL TYPE

A powerful, hand-operated clamping device assures a positive, gas-tight seal around the entire periphery of the valve. The goggle plate is released and clamped by the same powerful mechanism.



THERMAL
Made in diameters of 36" to 120"

MECHANICAL
60" x 48" Bailey Valve for Horizontal Gas Main. Sizes 6" to 72"

ENCLOSED
For use near open flame a totally enclosed type is furnished

Here is the means to instant service in shutting off gas mains in emergencies or for repairs . . . regardless of the length of time the valves stand unused. Soundly designed and built of the highest quality materials, Bailey Goggle Valves have repeatedly proved themselves dependable on gas washers, blast furnace mains, precipitators and boiler plants. With their positive, gas-tight seals, Bailey valves protect men and equipment, and assure economy through long, maintenance-free service.

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ENGINEERS
LEADERSHIP THROUGH QUALITY

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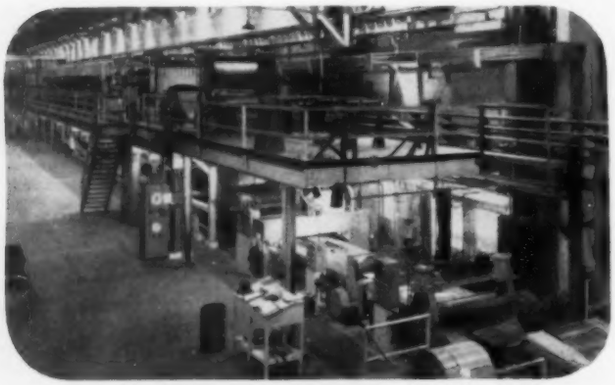
Galvanizing
Aluminizing
Bright Annealing and
Normalizing Strip ------ Continuously

Strip in single or multiple strands up to a total width of 54" may be bright annealed or normalized, continuously, in this EF gas fired radiant tube installation. Capacity 7200 lbs per hour.



A large capacity continuous strip normalizing, annealing and galvanizing unit. This is a combination EF gas fired radiant tube and electrically heated installation and is over 400 feet long.

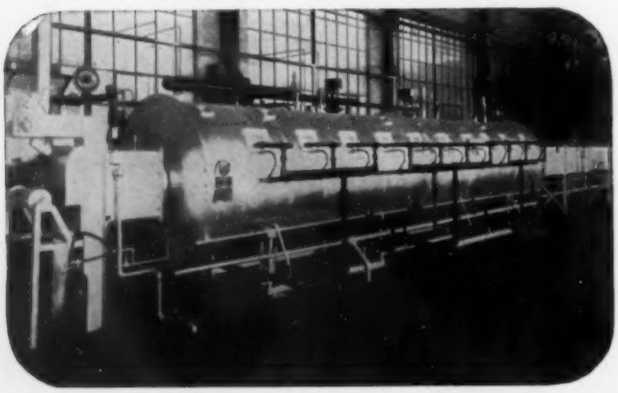
We are in position to design, build and put in operation; continuous strip lines for hot or cold rolled, high or low carbon, stainless, silicon, tinplate, aluminum, brass, bronze or any other ferrous or non-ferrous strip — for bright annealing, normalizing, galvanizing, aluminizing, tinning or any other process — in the size and type best suited to your plant, process, product or production requirements. No job is too large or too unusual.

Put your production furnace problems up to experienced engineers — *it pays.*

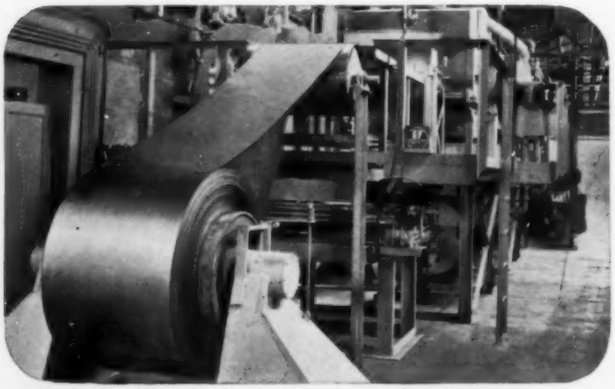
THE ELECTRIC FURNACE CO.

Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces



Stainless steel strip is bright or process annealed, continuously, in this EF gas fired special atmosphere tube muffle type furnace. It also handles other strip requiring lower temperatures.



An EF special atmosphere furnace with flame preheating burn-off or oxidizing section and controlled heating and cooling zones for producing various surface conditions on strip.

If You Want To REDUCE MANPOWER TURNOVER...

CUT HANDWORK CASUALTIES AND COSTS...

LET THE BILLETEER DO IT...

Be production-wise — go modern, with time-proven BONNOT BILLETEERING!

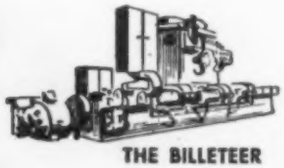
Right away manpower shortages and turnover problems solve themselves because OPERATORS appreciate the safety and speed and easy finger-tip control of the *Bonnot Billeteer*.

And YOU — with the speed and efficiency of *Bonnot Billeteering*, can better meet today's "quantity and quality" demands by stepped-up output of better-conditioned billets. *Billeteering* also enables you to reduce inventories — makes chips 100 recoverable — eliminates excessive re-melting — guarantees accurate scheduling — reduces inventory.

Your inquiry will bring prompt facts and figures on what can be done in your plant to meet the production demands and the cost problems of today's rapidly accelerating mobilization market.

Engineered for Improved Production

The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO



THE BILLETEER

Also Manufacturers of — SAWING • CRUSHING • PULVERIZING AND MIXING EQUIPMENT • BILLET INSPECTION TABLES
DUST PUG MILLS • SINTER PLANT PUG MILLS

Dependability...

—an Outstanding Feature of HAGAN Air-Operated Controls and Ring Balance Flow Meters

- Heat Input Control
- Fuel-Air Ratio Control
- Furnace Pressure Control
- Gas Pressure Control
- Gas Mixing Control
- Flow Meters for gas, steam, water, and compressed air
- Draft and Pressure Recorders
- Btu Meters for mixed fuels
- Control of multiple fuel firing
- Reversal Control

The production of steel presents complex metering and control problems. Wherever steel is made, Hagan Air-Operated Combustion Controls and Ring Balance Flow Meters solve them smoothly and efficiently. Simply designed and ruggedly built, Hagan equipment combines the utmost in reliability and accuracy, with a minimum of maintenance and operating expense. Applicable to all phases of the steel industry, Hagan Controls and Meters assure dependable service.

Experienced Hagan Engineers are ready to help you solve your steel mill metering and control problems. For information, write, wire, or phone:

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HAGAN BUILDING, PITTSBURGH 30, PA.

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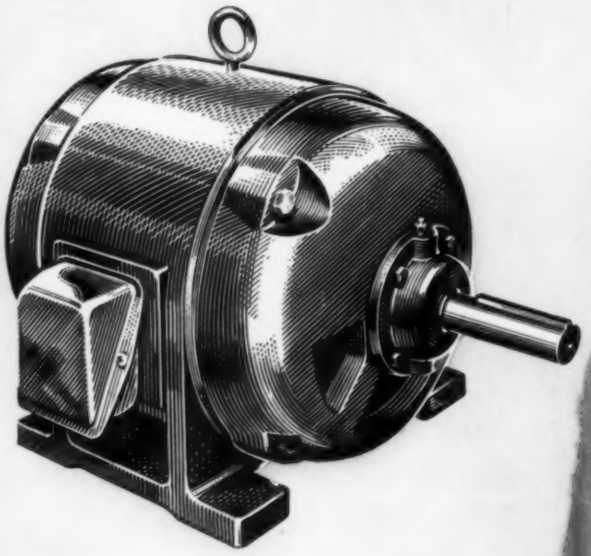
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
CONTROL SYSTEMS FOR AERONAUTICAL
AND AUTOMOTIVE TESTING FACILITIES

ELECTRO DYNAMIC

INDUSTRIAL MOTORS

Bred for BRAWN



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To give added years of dependable, low-cost operation, special skills and superior insulating materials are used to toughen the WINDINGS... "the heart of the motor." The frames and housings are of rugged cast construction for rigidity and resistance to corrosion.

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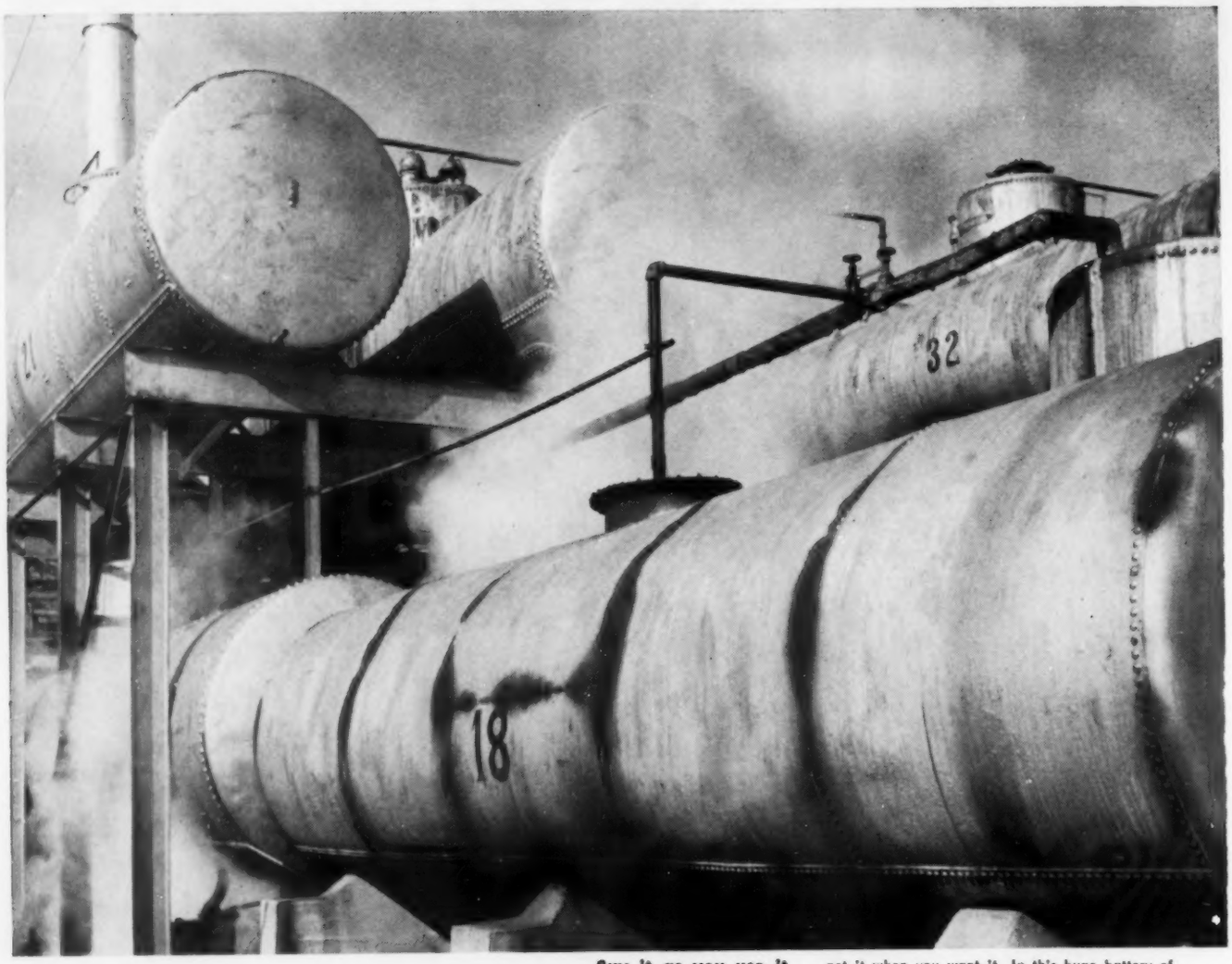


Buy it as you use it . . . get it when you want it. In this huge battery of heated tanks newly made Palmoshield is stored, ready for immediate shipment.

Not half a world away

. . . right in the heart of the industry!

Threats of war . . . shipping uncertainties . . . materials shortages. These headaches fade away when you use Palmoshield as the essential lubricant in your rolling operations.

For Palmoshield is an all-American lubricant made from freely available domestic materials in centrally located Columbus. You buy it as you use it. You get it when you want it. You need not tie up space or funds in stockpiling.

Introduced in January, Palmoshield is already in general use or on test by two-thirds of the major tin-plate producers of this country and Canada. Months of on-the-job experience have established the new lubricant as a proven replacement for imported palm oil.

Palmoshield is subject to exact chemical control; you can specify free fatty acid content to ½%—and get it. It looks, feels, acts, handles like palm oil; requires absolutely no changes in mill operation. It improves production, gives increased tonnage at less cost. Its price is not artificially controlled, but rises and falls freely with the domestic fat market.

To meet expanding demand, manufacturing and storage facilities have recently been greatly enlarged. Palmoshield is now available for immediate shipment in any quantity in both 55-gallon drums and tank car lots. For details write The Ironsides Company, 270 West Mound Street, Columbus, Ohio.

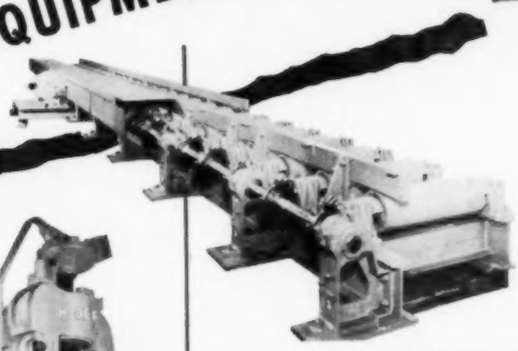
In emergencies overnight shipment can be made direct to your mill by tank truck not dependent on rail schedules.

SPECIAL LUBRICANTS and PRESERVATIVES

IRONSIDES SHIELD PRODUCTS **PALMOSHIELD**

Hyde Park ROLLS

and ROLLING MILL EQUIPMENT

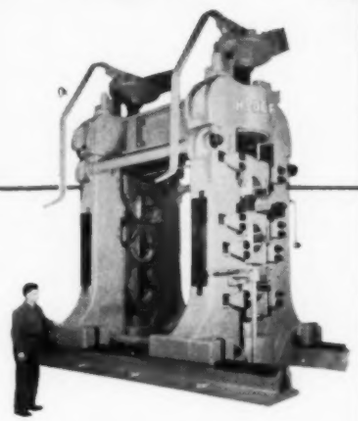


ROLLER TABLE

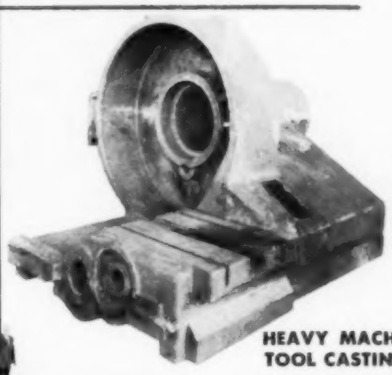
In many mills throughout the country Hyde Park Red Circle Rolls are daily giving top production, and achieving new endurance records.

The Hyde Park Red Circle is your assurance of quality and dependability. You will find it on the type and size of roll that will best serve your purpose.

The same integrity of design and rugged construction are characteristic of all Hyde Park Rolling Mill Equipment.

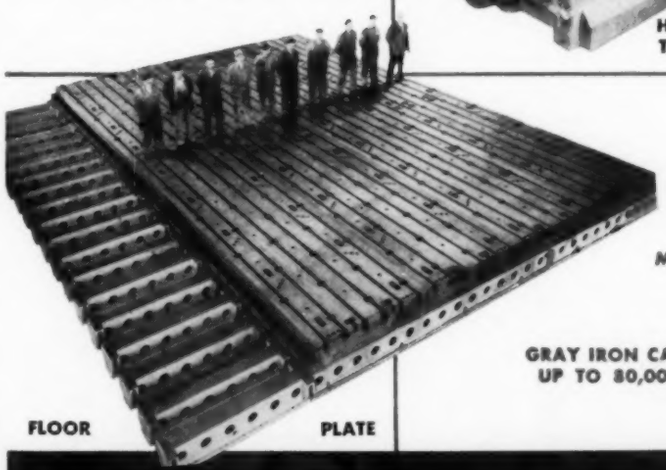


24 INCH
3 HIGH BAR MILL



HEAVY MACHINE
TOOL CASTING

12 INCH
3 HIGH BAR MILLS



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- Bar Mills
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GRAY IRON CASTINGS UP TO 80,000 LBS.

- Machinery Castings
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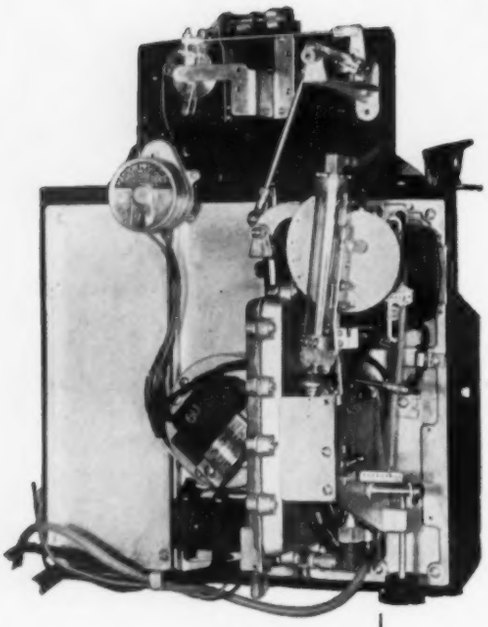
Hyde Park FOUNDRY & MACHINE CO.
HYDE PARK, WESTMORELAND COUNTY, PITTSBURGH DISTRICT, PA.

a new low differential flow meter to measure . . .

air flow

gas flow

or air flow-gas flow ratio



hays diaflow meter

The Hays Diaflow Meter is a *new* low differential flow meter for measuring air flow, gas flow or recording the ratio of air flow to gas flow. Especially adaptable for industrial furnaces and sewage disposal plants, the Diaflow meter is used as a guide in achieving product, process and cost control.

Employing the pilot method of operation the diaphragm measuring element will accommodate static pressures up to 10 lbs. and differential pressures up to 20″ water. Write today for Bulletin 52-1017-37 containing complete information on the new Diaflow meter.

features

PILOT METHOD
provides higher sensitivity and greater accuracy . . . no load placed on measuring element.

DRY, DIAPHRAGM MEASURING
—no messy fluids . . . no leveling required.

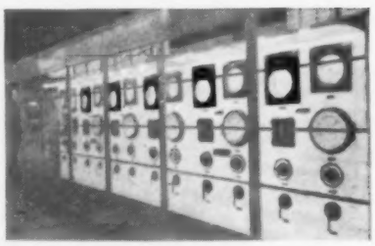
UNIT CONSTRUCTION
—easy parts removal without affecting calibration.

PIVOTED CONSTRUCTION
—internal parts accessible from front of case . . . no special tools required.

HIGHLY ADAPTABLE
—wide variety of models fit most measuring requirements.

DUAL FLOW
—gas and air flow records can be coordinated for efficient combustion.

applications



Industrial Furnaces—Diaflow measurement in open hearth, soaking pit, billet, slab heating and annealing furnace indicates excessive amounts of air and/or gas . . . helps to prevent fuel and gas waste . . . serves as a guide in maintaining product quality.

Sewage Disposal Plants—A guide to proper control of sewage treatment processes. Diaflow metering indicates: load on plant, variations in functions, relative rate of fluid flow and a continuing check on costs.

Automatic Combustion Control
Boiler Panels • Hays-Penn Flowmeters
Veriflow Meters and Veritrol
Gas Analyzers • Draft Gages
Combustion Test Sets • CO_2 Recorders
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THE **hays** CORPORATION

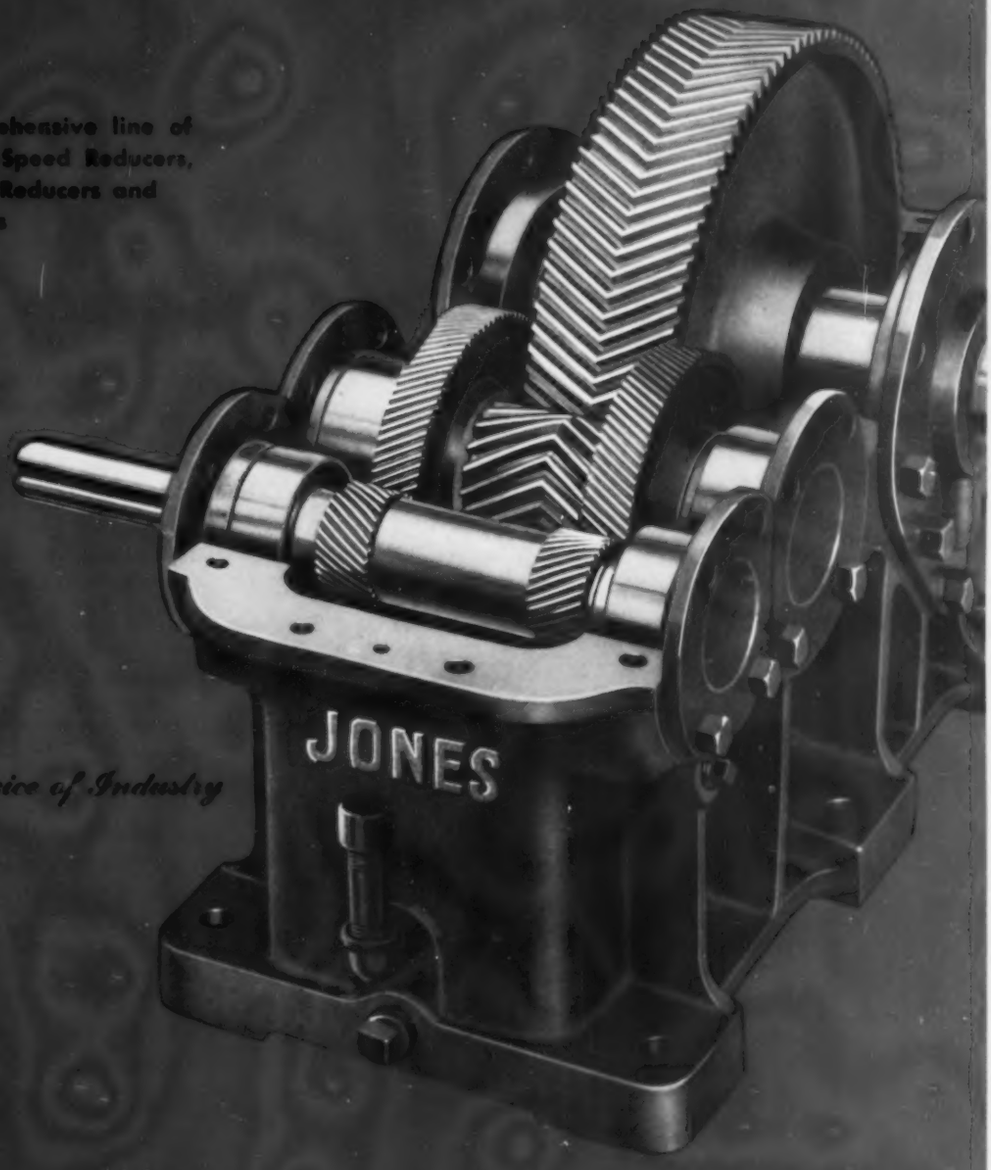
MICHIGAN CITY 13, INDIANA

MORE STANDARD SIZES TO CHOOSE FROM

In the range from 1 to 400 horsepower JONES offers the most complete line of Herringbone Gear Speed Reducers available *ANYWHERE*.

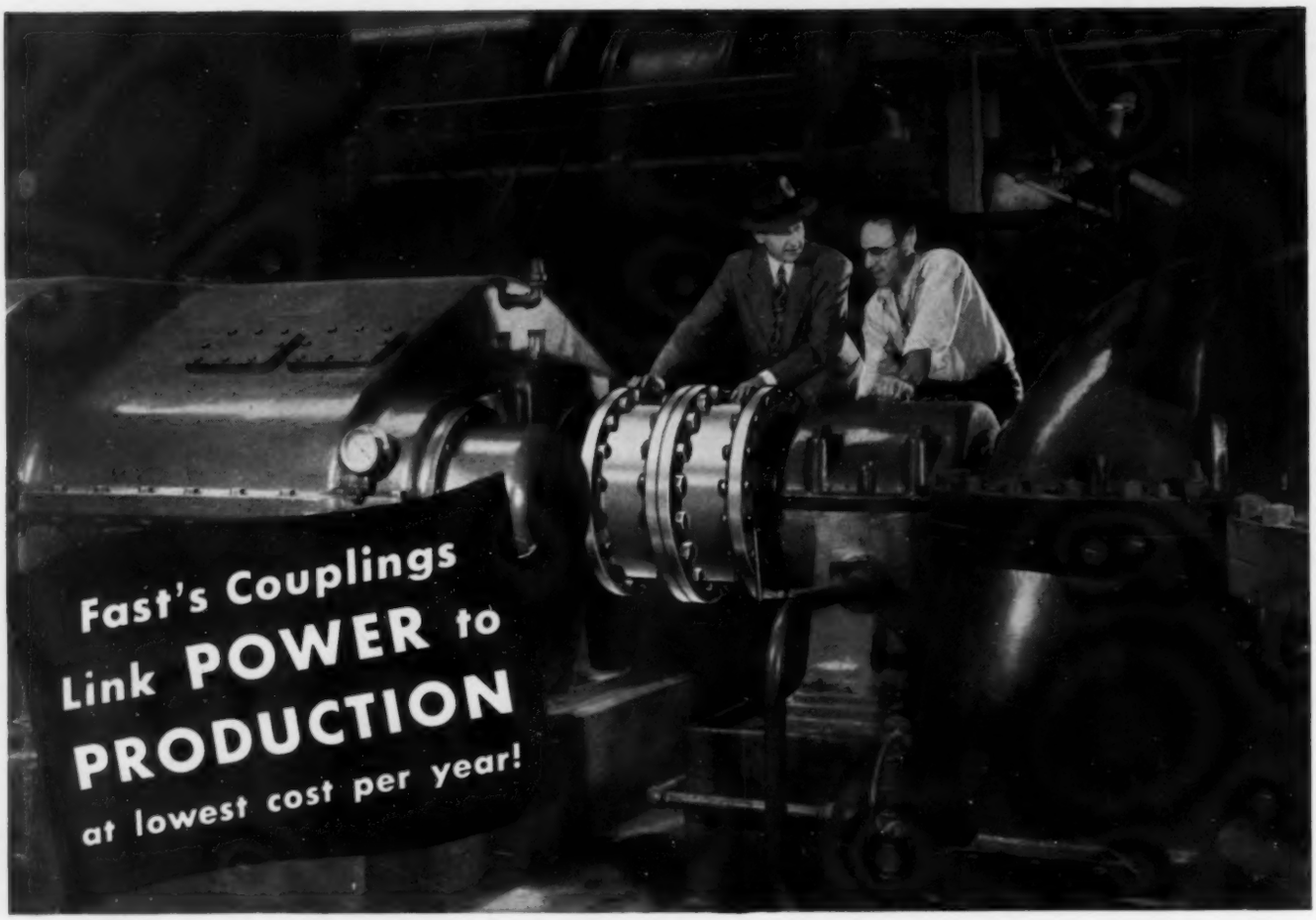
Jones

Manufacturers of a comprehensive line of quality Herringbone Gear Speed Reducers, Worm Helical Gear Speed Reducers and Worm Gear Speed Reducers



Since 1890... In the Service of Industry

W. A. JONES FOUNDRY & MACHINE COMPANY, 4401 Roosevelt Road, Chicago 24, Illinois



Over half a million FAST'S Couplings now in use!

THROUGHOUT industry, Fast's are rated the most dependable couplings on the market . . . to the tune of over half a million now in service! Year in, year out, they continue to *outlast the equipment they connect* . . . save time, maintenance and money by eliminating costly coupling failures.

Actual cases on record show many Fast's Couplings have been in operation for 25 and 30 years without trouble. And every major producer of high-speed equipment now uses Fast's!

Solve your coupling worries! Write today for full details on Fast's Couplings and Koppers Engineering Service to: KOPPERS COMPANY, INC., *Fast's Coupling Dept.*, 219 Scott St., Baltimore 3, Maryland.

Here's How FAST'S Save You Money

Free Service—Koppers free engineering service assures you the right coupling for the job.

Rugged Construction—Fast's still maintains its original design, without basic change or sacrifice in size or materials. Result: freedom from expensive coupling failures.

Lowest Cost per Year—Fast's Couplings usually outlast equipment they connect. Their cost may be spread over many years!

KOPPERS®

FAST'S
THE ORIGINAL
GEAR-TYPE
Couplings

INDUSTRY'S STANDARD FOR 32 YEARS

KOPPERS COMPANY, INC., *Fast's Coupling Dept.*
219 Scott St., Baltimore 3, Md.

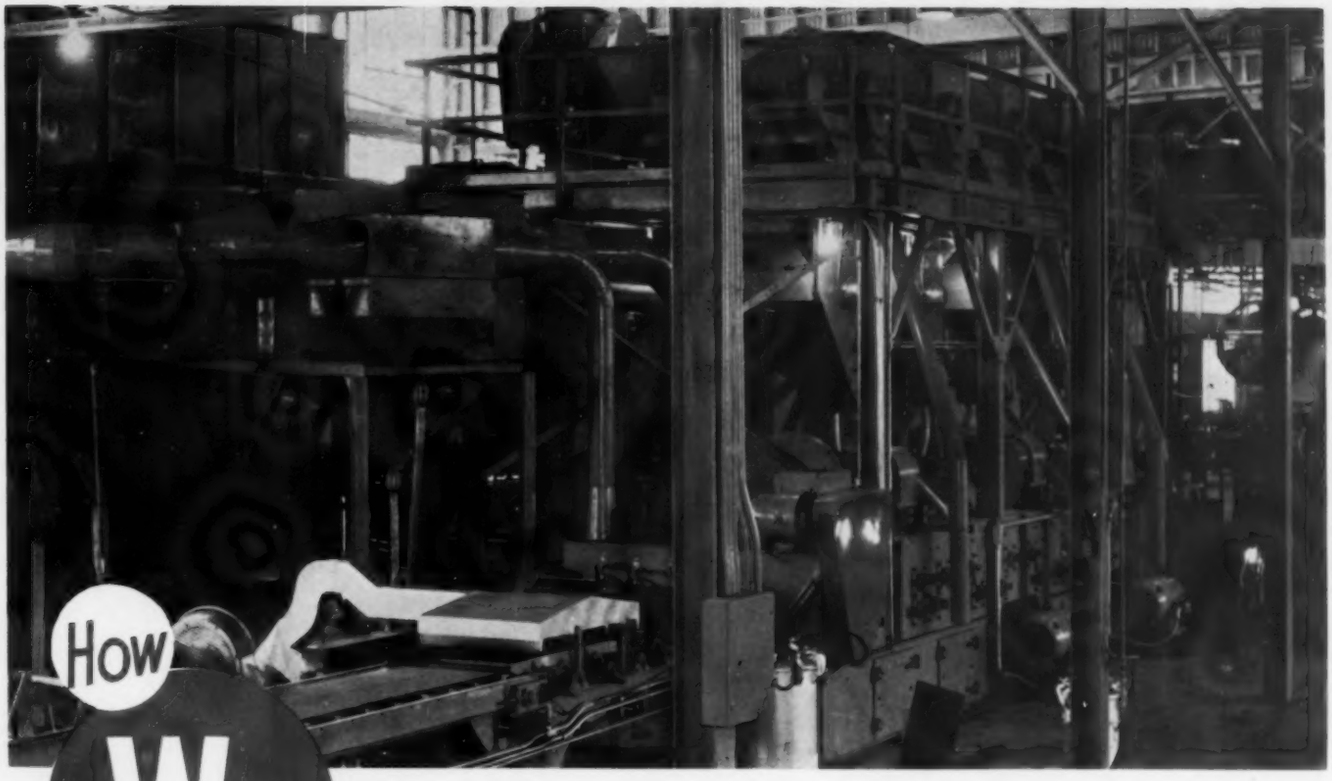
Gentlemen: Send me Fast's Catalog which gives detailed descriptions, engineering drawings, capacity tables and photographs.

Name .....

Company .....

Address .....

City ..... *Zone* ..... *State* .....



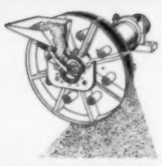
How WHEELABRATOR® MECHANICAL CLEANING of Hot Rolled Steel Sheets *Reduces Cleaning Costs per Ton*

Operating results of airless Wheelabrator mechanical cleaning equipment for removing scale from hot rolled steel sheets have proved that other methods do not equal its cost-cutting performance and high speed cleaning efficiency.

In each of the seven drum plants of Rheem Manufacturing Co., for example, Wheelabrator machines have greatly reduced the cost of cleaning 18-gauge steel sheets used in the manufacture of their new Rheemcote lithographed steel drums. In other steel processing plants and steel mills, the Wheelabrator is also effecting impressive results in low cost, high production and providing extra benefits in improved surface cleanliness and better working conditions.

These production economies are a result of perfected equipment design coupled with the controlled abrasive blast of the Wheelabrator unit. With the introduction of Tru-Steel Shot, equipment operating and maintenance costs are extremely low and continuous, high-production mechanical cleaning of hot rolled products is now in actual practice.

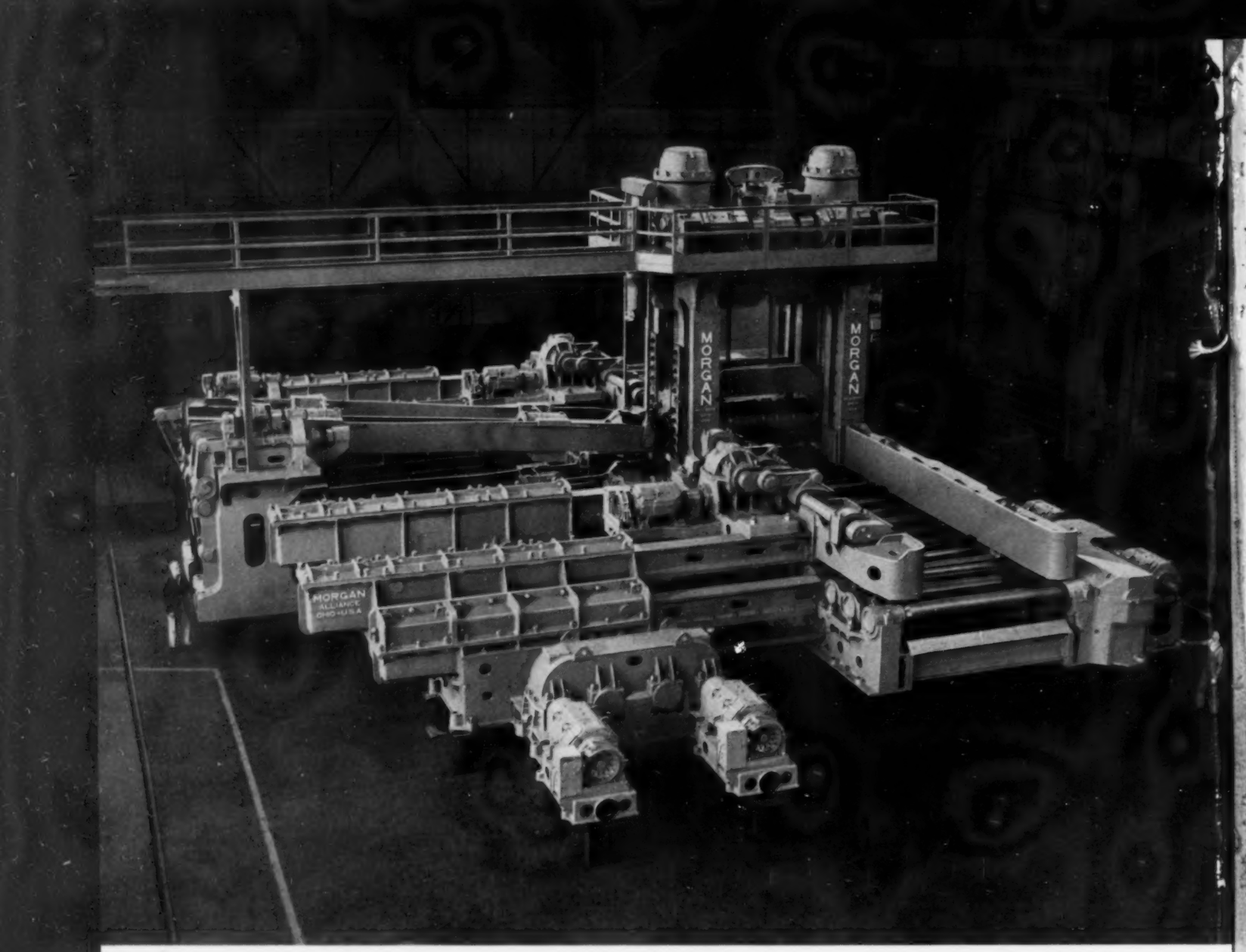
We would be glad to demonstrate the savings the Wheelabrator can make for you. Write today for full details and an appointment to see the Wheelabrator in operation.



WHEELABRATOR — The perfected airless centrifugal blast unit pioneered by American scours away scale and dirt mechanically at low cost. Provides a more uniform etch for mill rolls, effects unusual economies in cleaning strip, sheet, bar stock and skelp.

American
WHEELABRATOR & EQUIPMENT CORP.
396 S. Byrkit St., Mishawaka, Indiana

WORLD'S LARGEST BUILDERS OF AIRLESS BLAST CLEANING EQUIPMENT



44" TWIN MOTOR DRIVE BLOOMING MILL

Morgan 44"—2 High Reversing Blooming Mill to be direct connected to two 4000-Hp., 50/120 Rpm. Motors. Top roll and both spindles are hydraulically balanced by individual cylinders connected to an air hydraulic system. Speeds of motor driven screw down, feed rollers, mill tables and manipulator are regulated by variable voltage control.

Mill tables have box type cast steel girders. Rollers are forged steel equipped with anti-friction type bearing cartridges. All gears have hardened teeth, are totally enclosed and operate in oil. Manipulator is of the electric overhead type with retractable heads affording maximum accessibility to all parts of the mill tables.

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HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL

Equipment News...

GIANT STATOR

▲ Two years of transportation planning were climaxed recently with delivery of a giant General Electric 401,000-lb stator for one of the world's largest generators in Consolidated Edison's East River Station at New York, N. Y.

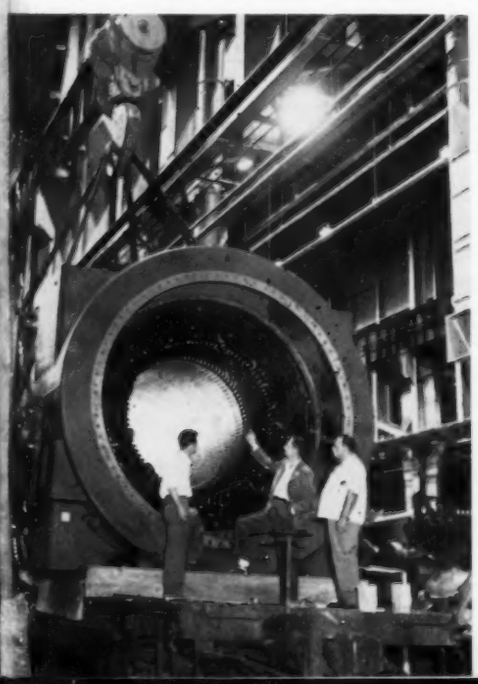
Taxing transportation facilities enroute from the G-E turbine manufacturing center at Schenectady, the huge stator moved by rail, water and heavily reinforced trailer to the powerhouse at 14th street and East River Drive.

Two railroads, a specially-built flat car, one of the world's largest floating derricks, a lighter (special barge), two tugboats, and a Manhattan firm of heavy hauling specialists were needed to move the giant 30-ft long component of a 175,000-kw generator.

When loaded on the specially-built flat car, the stator was 12 ft 7 in. wide and 17 ft 1 in. above the surface of the rails. It could not clear the tunnels and rock cuts of a direct rail line to New York.

During the past two years, engineers, shipping and transportation experts of General Electric had carefully measured every step of the way. The first part of the journey was from G-E's turbine plant at Schenectady to Jefferson Junction, near Binghamton, N. Y. via Delaware & Hudson Railroad.

The 401,000-lb G-E stator is shown resting on its specially-built flat car.



From Jefferson Junction, the Erie Railroad ran a special train to Jersey City's Marine Dock, Pier No. 1.

On both railroads, the weight, width and height of the load limited speed to from 5 to 30 mph, and trains hauling the unit moved only when all adjacent tracks were clear. The trip from Schenectady to Jersey City took two days.

From the track at the edge of Marine Dock, Jersey City, the biggest commercial floating derrick in the U. S., the "Monarch," operated by Merritt-Chapman & Scott Corp., hoisted the load from flat car to lighter.

With a capacity of 250 tons when the center of load is ten feet or less from the center of the derrick, the "Monarch" handled the 401,000-lb stator with ease, despite being near limit of its rated capacity.

The lighter was towed by tug around the lower end of Manhattan to the foot of 34th street on the East River, where the "Monarch" lifted it to a reinforced tractor-trailer operated by the Gerosa Haulage Corp.

The unit's bulk made necessary a special route through the city approved by the New York Board of Transportation. The Gerosa concern had used a mock-up of the unit to rehearse the difficult movement. So small were clearances on some turns that lines were painted on the street for guidance of those handling the job.

Careful planning coupled with expert handling resulted in delivery of the stator without incident, despite clearances which in some cases were less than one inch and loads which came within a few hundred pounds of rated capacity.

DESK-TOP TRANSMITTER

▲ As a component of its new line of 450 mc two-way radio equipment, Motorola, Inc., is releasing a locally controlled base station housed in a desk-top cabinet.

This model is designed for use in the 450 to 460 mc range as well as the 460 to 470 mc range which is the much publicized citizen's radio band as defined by the FCC. The principal advantage of operation in either of these bands is elimination of the channel crowding encountered on lower frequency bands. Other advantages are less interference, lower noise levels, easier licensing and extra channels for system expansion.

The lower frequency band is restricted to use by organizations involved in land transportation, public safety, and domestic and industrial public services. The higher band is open to individuals and organizations who were previously ineligible.

The unit designed for use in the 450 to 460 mc band has a nominal power output of 20 watts.

The transmitter contains the instantaneous deviation control circuit patented by Motorola which restricts deviation to the limits set by the FCC. A coaxial line filter reduces the spurious and harmonic radiations to an absolute minimum.

The base station is the companion piece of the previously released mobile unit.

ELECTROLYTIC CONDITIONER

▲ Oakite Products, Inc., manufacturers of specialized cleaning and allied products, have announced the addition of Oakite "Composition No. 95" to their line of electrocleaning materials. It is designed primarily as an electrolytic conditioner for zinc base die castings in preparation for plating.

In cleaning-conditioning of zinc base die castings, the manufacturers report the composition as offering the following advantages: (1) Fewer rejects—the composition anodic conditioning process removes the surface films, disturbed metal and last traces of soil that are among the major causes of peeling and blistering. It also avoids the hydrogen gas formations that raise blisters when castings

are heated after electroplating. Experience with this composition, the manufacturers state, shows that no blisters appear in plating on sound surfaces during the severe test of one hour of baking at 300 F. Even in highly porous areas, heat blistering is effectively minimized; (2) Brighter plating — anodic conditioning with this composition removes all films that might impair the brightness of subsequent electroplates. The controlled, uniform action eliminates under-surface shadows caused by the deep etching of harsh cleaners. The composition rinses so freely that even with dry-down times as long as one minute—as in automatic plating —no residue films appear on the castings; (3) No blackening during anodic cleaning—castings do not lose their brightness during the evenly-controlled composition conditioning process, it is claimed.

FOR EXTRA SERVICE and GREATER ECONOMY
Use BUCKEYE Silica Firestone!
• FOR SOAKING PITS
• FOR BESSEMER CONVERTERS
• FOR BLAST FURNACE LADLES
• FOR MIXERS
• FOR GRAY IRON CUPOLAS
• FOR MALLEABLE AND DROP FORGE FURNACES
Nature has endowed Buckeye Silica Firestone with every feature needed in modern refractory material. Its widespread efficiency, long life and attractive cost are well known to foundry and steel mill executives everywhere.
Under conditions where comparative tests have been made, Buckeye is first everytime! Its natural, uniformly-balanced combination of chemical and mechanical properties makes its superiority unquestioned. Its microscopically open and porous structure provides exceptional resistance to heat and abrasion.
Decide today to take advantage of Buckeye's many time-saving and money-making features. Write us at no obligation.
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BUCKEYE
"FOR THAT EXTRA SERVICE"
SILICA FIRESTONE

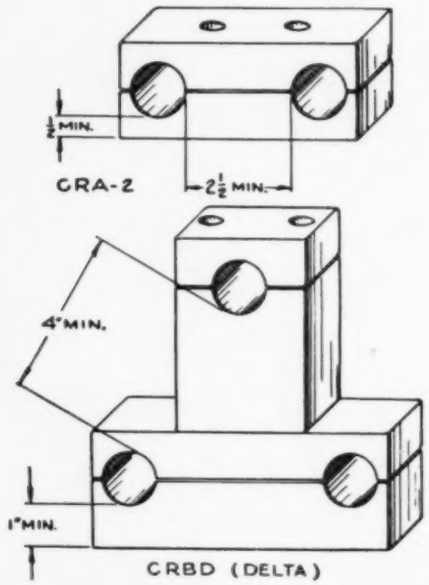
EXTRUSION UNIT

▲ The first extrusion installation in the United States for hot forming of steel shapes by the Ugine-Sejournet Process—using glass as a lubricant—was designed and built by Hydropress, Inc. The machine which has a capacity of 2,500 tons is in successful operation at Babcock & Wilcox Co., Tubular Products Division, Beaver Falls, Pa. Prior to extrusion of tubular shapes the billets are pierced on a Loewy-Hydropress-built hydraulic piercing press of 500 tons capacity.

Another 2,500 ton Loewy-Hydropress extrusion installation for manufacturing steel shapes by means of the glass-lubrication method will go into operation shortly while two others of 1,000 ton and 1,650 ton capacities are under construction.

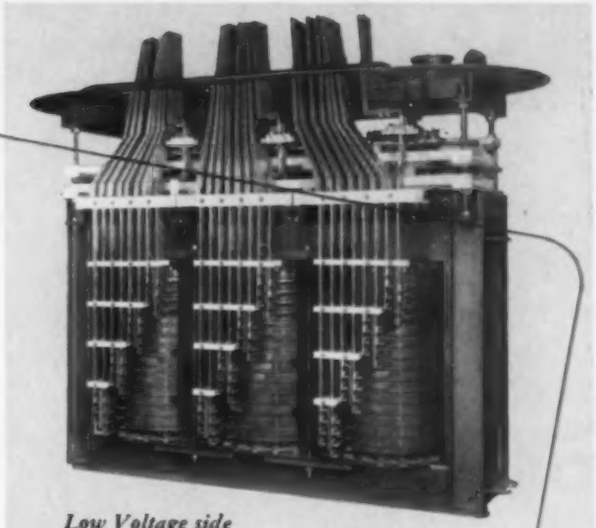
CABLE RACK

▲ Adalet Manufacturing Co. announces an addition to its line of electrical conduit fittings. This is a series of phenolic insulating cable racks. Keynote of material quality is summed up in two words—"canvas

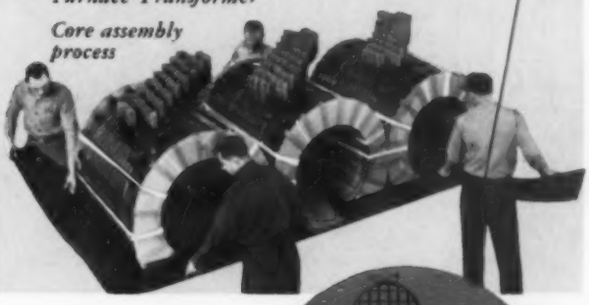


base"—which gives added strength and endurance to the "Sali" laminated phenolic insulating material of which they are made. It is believed that the Adalet cable rack is the only rack available made of strong canvas base insulating material. High tensile, flexural and dielectric strengths of the material are the same as found in other Sali fittings manufactured

How Pennsylvania solves 3 major Furnace Transformer Problems



Low Voltage side of 18,000 Kva Furnace Transformer



Core assembly process

The complicated design of a furnace transformer presents many problems that do not apply to other types of transformers. Many special conditions such as overloads, short circuit stresses, distribution of currents and reduction of eddy losses must be met by engineering skill and highly perfected workmanship. Here is how Pennsylvania Transformer Company solves three of these major problems:

1. **OVERLOADS AND SHORT CIRCUIT STRESSES** Electric Furnace operation inherently subjects Furnace Transformers to frequent short circuits and heavy overloads. The effect of this on the transformer is complicated by the wide range of voltages which necessitates cutting out large portions of the primary windings. The effects of both the radial and axial short circuit forces are greatly reduced in Pennsylvania Furnace Transformers by the use of Circular Coils and an ingenious winding arrangement.

2. **BALANCING OF STRESSES** Pennsylvania coils are balanced to reduce the radial and axial short circuit stresses to a minimum. 1. The circular shape protects the coils against deformation due to radial short circuit forces. 2. The total axial short circuit force is calculated for each design and the coils are subjected to an equivalent pressure in an hydraulic press. The ability of the coils to maintain their shape, under the prescribed pressure, guarantees that the transformer will safely withstand short circuits.

3. **DISTRIBUTION OF CURRENTS** Due to the heavy secondary currents, the winding must be subdivided into numerous parallel sections. A unique arrangement of the windings insures that each section carries an equal share of the current.

   Careful transposition of the individual conductors of each section in the windings reduces the copper eddy losses to a minimum. This results in improved efficiency, more uniform copper temperature and prevention of hot spots.

Furnace Transformer Experts

Pennsylvania TRANSFORMERS

Pennsylvania TRANSFORMER COMPANY

CANONSBURG, PENNSYLVANIA *Greater Pittsburgh District*

Seeing more than Argus with the DIAMOND "UTILISCOPE"

(WIRED TELEVISION)

"UTILISCOPE" RECEIVER

"UTILISCOPE" CAMERA

Argus, according to Greek mythology, had a hundred eyes, not all of which ever slept at once. He'd have been ideal for watching many industrial operations except that he couldn't see around corners, through walls, sit close to a potential explosion or look inside a furnace.

The Diamond "Utiliscope" (Wired Television) is much better than Argus with all his hundred eyes. The "eye" or camera is connected to the viewing screen by cable, so the "eye" can be practically anywhere . . . no matter how remote, dangerous, or difficult. Multiple "eyes" to any number are available just by adding more cameras and viewers. The "eyes" may be scattered all over a big plant, and all the images brought before one operator. Argus couldn't approach that.

And the "Utiliscope" doesn't sleep at all . . . will watch continuously 24 hours a day. Image is always clear and stable . . . the "Utiliscope" has no human limitations.

If you have any operation too remote, dangerous or inaccessible to observe directly . . . or if you need to have a single observer watch a number of widely scattered operations to assure their coordination, investigate the "Utiliscope."

TYPICAL USES— Studying destructive tests of engines • Watching flow of molten steel • Checking remote gauge readings • Observing conditions inside furnaces Viewing nuclear research • Coordinating materials flow on conveyors.

The "Utiliscope" (Registered U. S. Patent Office)

WRITE FOR BULLETIN 1025-E

DIAMOND POWER SPECIALTY CORP.

FIRST IN INDUSTRIAL TELEVISION

LANCASTER, OHIO • OFFICES IN 39 PRINCIPAL CITIES

Diamond Specialty Limited — Windsor, Ontario

Since 1903, Diamond has Manufactured Quality Equipment For Industry

by the company. The series is divided into two groups as required by the National Electric Code for 300 volts and under, or over 300 volts. Standard racks have maximum size holes possible to maintain required clearances. Mounting bolt holes take standard size bolts.

A modification of the standard carrier rack is also available. This is the clamping type, and holes are drilled to fit specified cable diameters. Any hole sizes can be provided not exceeding the hole diameter of the standard rack. Length of the grip is ample for support of rubber and synthetic covered cable. The new cable rack series covers a complete range of types and sizes, including the delta arrangements.

DIVERTER VALVE

▲ A newly-designed diverter valve announced by the Industrial Truck Division of Clark Equipment Co., makes possible for the first time economical installation in the field of a number of special hydraulic attachments.

By means of the valve, the truck's hydraulic system for tilting the upright can be utilized to operate the special hydraulic attachment, using the standard tilt lever as the means of control. When the diverter valve plunger is in the "up" position, oil is diverted to the attachment. When the plunger is in the "down" position, oil flows to the tilt cylinders, and the truck operator has normal control of tilting. Simultaneous operation of the attachment and tilt cylinders is impossible.

The new valve offers advantages in situations where installation of an auxiliary valve, for a hydraulic device would ordinarily be too costly or time-consuming; or in the case of old

An invitation to discuss proved ways to greater yield...

EVERY step of the way in modern steel production—from mine to finished product—Link-Belt conveying and power transmission machinery offer important savings. Mills all over the country find this proved equipment the sure way to boost yield.

Link-Belt conveyors step up production, reduce waste in moving coils weighing up to 75,000 lbs. Similar economies are provided in the handling of coal, coke, ore and other bulk materials, rods, slabs, billets, plates, pipe, scrap.

At the show, stop at the Link-Belt booth to talk over your problems. If you won't be there, call the engineer in the Link-Belt office near you. He'll be glad to sit down with your own engineers, consultants and builders of mill and process equipment. Together, they'll give you a conveying system that meets your exact requirements.

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MATERIALS HANDLING, PROCESSING and POWER TRANSMISSION MACHINERY

LINK-BELT COMPANY — Plants: Chicago, Indianapolis, Philadelphia, Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices in Principal Cities. 12,906

TM Alloy Steel
CHAINS
DO MORE WORK, LAST LONGER,
COST LESS . . . THAN WROUGHT IRON TYPES

This Registration Ring bears the chain's serial number and safe working load. It's your assurance of thorough testing and inspection.

Your chain problems are substantially reduced when you buy TM Alloy Steel Chain. Records prove this famous chain *outlasts* and *outperforms* wrought iron types . . . even under the toughest conditions. It's more economical too!

TM Alloy Steel Chain has twice the tensile strength. Controlled heat-treatment assures a uniform hardness of from 265 to 285 Brinell. These features make it highly resistant to abrasion, cold-working, grain growth and shock at all temperatures.

Send for free booklet containing all the facts and specifications on TM Alloy Steel Chain and attachments.

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Dept. 5, Hammond, Indiana
Rush literature and prices on TM Alloy Steel Chains.

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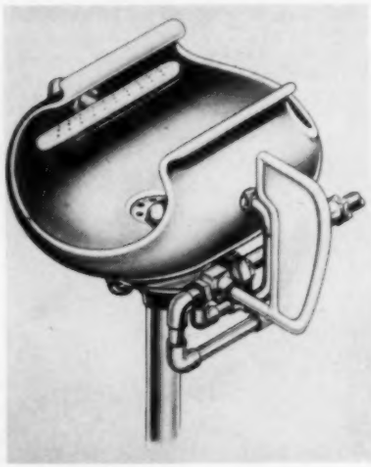
TAYLOR MADE
A GREAT NAME IN
Chain SINCE 1873

models where major modification would be necessary, making field installation impossible.

EMERGENCY FOUNTAIN

▲ There has been an alarming increase in the number of accidents involving eyes, ears, nose and mouth resulting from acid burns, dust, fumes, heat and contamination. This in turn has created the demand for an eye-wash fountain that would instantly wet all parts of the face but without danger of recontamination.



To meet the need Logan Emergency Showers, Inc., have developed an eye, nose and mouth wash fountain. This fountain uses entirely new principles of spraying.

With the knowledge gained from exhaustive research, that immediate, thorough wetting of the face may save precious eyesight, or prevent disfiguration caused by acids, explosions, fumes, heat, chemicals, fire, etc., the Logan fountain is designed to gently spray a large volume of water at what amounts to neutral pressure.

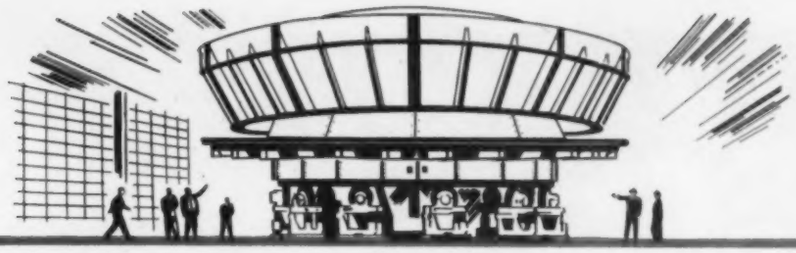
This ingenious design of spraying equipment embodied in the Logan fountain eliminates the danger of back syphonage, or cross-connection and thus makes available now for the first time an eye-wash fountain that fully meets all known industrial hygiene recontamination regulations and plumbing and sanitary standards.

The Logan fountain comprises a porcelain-enameled bowl with all piping and fittings of red brass, chromium plated. It is actuated by a non-leak, bat-wing valve. It comes in pedestal type, or for wall mounting.

POWER CABLE

▲ "Super Coronol" power cable for

McKee 16
Wind Box
Sintering Machine



POLLOCK

chosen to construct latest sintering plant equipment

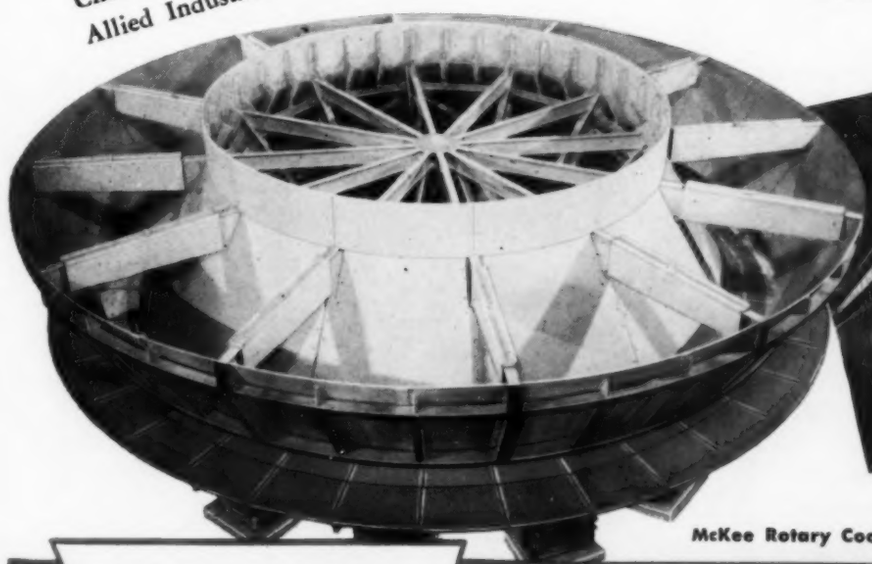
POLLOCK ALSO MAKES . . .

Miscellaneous Welded and Riveted Steel Plate Work for Blast Furnaces and Steel Plants, Oil Refineries, Chemical Plants and Allied Industries.

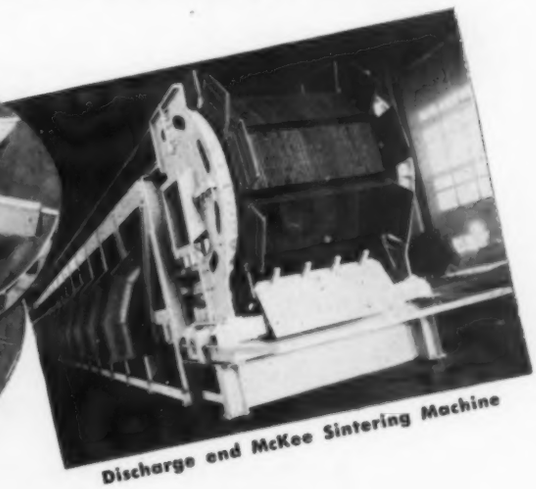
TO construct its newly developed sintering plant equipment, Cleveland's Arthur G. McKee Company chose The William B. Pollock Company, steel plate construction experts since 1863.

This latest sintering machine and rotary cooler were assembled in Pollock's Youngstown, Ohio plant and inspected by the customer and many interested iron and steel operators and engineers while in test operation. Then it was thoroughly match-marked, disassembled, and loaded on 16 railroad cars in such a way as to insure quick and efficient field erection.

Pollock is known the world over for its reliable, efficient heavy plate construction.



McKee Rotary Cooler 48 Ft. 4 In. Diameter



Discharge end McKee Sintering Machine

POLLOCK

THE WILLIAM B. POLLOCK COMPANY
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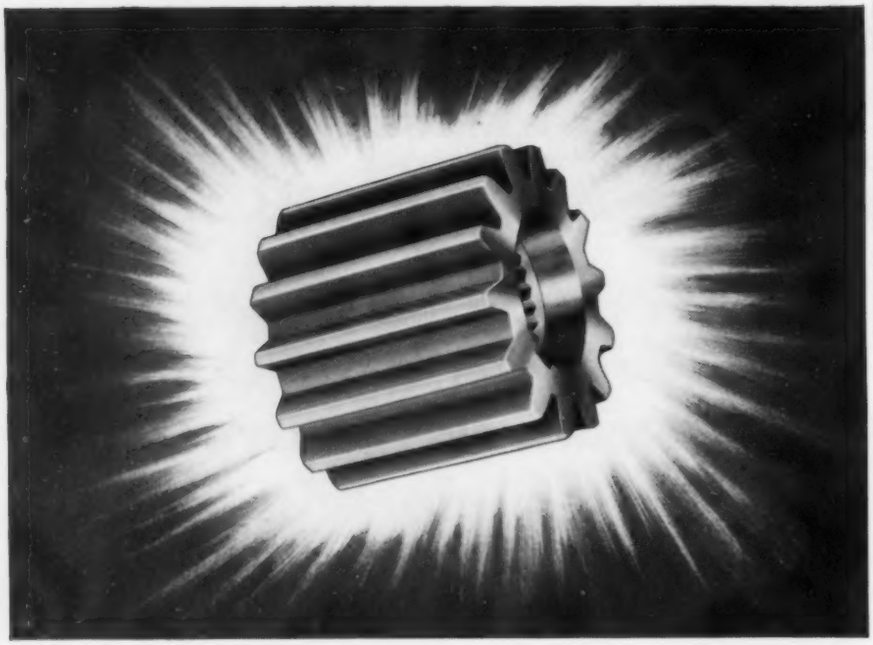
STEEL PLATE CONSTRUCTION · ENGINEERS · FABRICATORS · ERECTORS

BLAST FURNACES · HOT METAL CARS AND LADLES · CINDER AND SLAG CARS · INGOT MOULD CARS · CHARGING BOX CARS · WELDED OPEN HEARTH LADLES



This Pittsburgh Purple

ARMORED Gear

might save you a good many dollars

Increasing gear life may be a real problem for you but it's our business. It is something we do by combining design, metal, and machining with a special heat-treating process and experience we have gained making quality gears since 1914.

The PITTSBURGH Armoring process puts the right hardness in the right places. It makes the wearing surfaces hard but leaves the core tough and shock-resistant. **Armored Gears** are so good that we guarantee them to give you longer service.

By changing to PITTSBURGH **Armored Gears** in a product you make, or on a machine you use, you might save a good many dollars. Our engineers will gladly consult with yours to work out a solution. Write us today for prompt attention.

Look for the "**Pittsburgh Purple**" protective coating on the gears you buy.

VISIT BOOTHS 480-481

SPUR
MITRE
HELICAL
HERRINGBONE
WORM GEARS
REDUCERS
CRANE WHEELS

Your Guarantee of Longer Life

PITTSBURGH GEAR COMPANY | 27th & Smallman Streets, Pittsburgh 22, Pa. Phone: ATlantic 1-9950 — 8346-AS

subsidiary of BRAD FOOTE GEAR WORKS, INC. • CICERO 50, ILLINOIS

service up to and including 8000 volts is now rated at 85 C copper temperature according to General Electric's wire and cable department.

It is believed that this is the highest rating ever announced for a solid dielectric power cable in this voltage range. The new temperature ratings mean that these cables are now capable of carrying up to 12 per cent more power, continuously, than old-style ozone-resistant rubber-type compounds rated 75 C maximum.

This higher rating is based on life test of many cables taken from regular production. One of the most impressive tests involves cable held continuously under load at a copper temperature of 121 C. This test is now nearing the end of its fifth year and both physical and electrical properties have been stable since the 20th month. In view of such results, G-E wire and cable engineers believe that the new rating is still extremely conservative. The new rating can also be safely applied to all of this type cable now in service at potentials up to 8000 volts. For voltages above 8000, ratings continue to be based on 80 C.

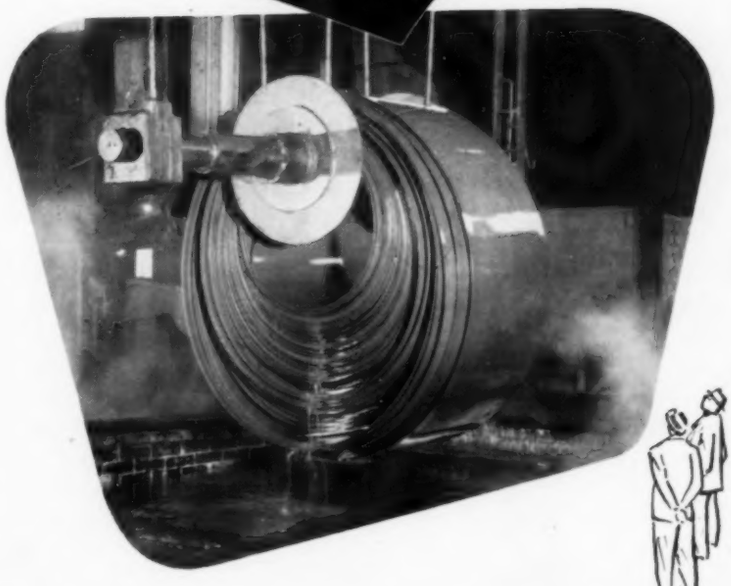
ELECTRIC-POWERED STACKER

▲ Factory and warehouse aisles half their present width have been made possible by development of a compact electric powered stacker that can tier goods 11 ft high in aisles only six ft wide.

The new materials handling unit, called the "Transveyor," was introduced by the Automatic Transportation Co. It is for use where narrow aisles, close quarters, and limited floor or elevator capacity are factors.

With a Low-Cost WELDCO Mechanical Coil Pickler Like This

You Get Uniform Pickling Like This



The new Weldco Mechanical Coil Pickler was designed especially for semi-continuous pickling in medium and low-tonnage mills. Economical and space-saving, it cuts manpower and maintenance expense to the minimum, while giving you thorough, uniform pickling in less time. For example—note the completely cleaned coil at the left, after processing in our McKees Rocks, Pa., installation. This 14-gauge steel was pickled *in 9 minutes* in a 12-14% sulphuric acid solution at 180°-200° F.

The Weldco unit assures efficient, inexpensive, individual coil pickling. Its flexibility permits you to pickle several different widths at the same time—eliminates down-time—resetting for size—hairpinning!

The Weldco Mechanical Coil Pickler is available in any capacity up to 25,000 tons per month, and with a small investment in handling equipment, can be used to pickle sheets, plates and bars. (For successful pickling of strip, a satisfactory scale breaker and loose coiler are required.) It will pay you to get complete details on this new, low-cost Weldco Pickler. Contact us for further information, and for complete engineering service on your entire pickling line.

THE YOUNGSTOWN WELDING & ENGINEERING COMPANY

3706 OAKWOOD AVENUE · · YOUNGSTOWN 9, OHIO

BETTER LONGER!

RUN-OUT TABLE
ACTUAL SERVICE RECORDS
OF THREE YEARS
WITHOUT
MAINTENANCE

★ On run-out tables, as well as on other equipment, Lovejoy Flexible Couplings are giving outstanding performance. They feature free-floating load cushions suspended between heavy metal jaws. Cushions will last two to five years *and there is no shut-down for changing.* These couplings instantly counteract mis-alignment, vibration, backlash and surge. To eliminate costly break-downs and shut-downs due to coupling failure on run-out tables and other equipment, use Lovejoy Flexible Couplings. No lubrication ever required.

WRITE FOR COMPLETE CATALOG AND HANDY, QUICK-FINDING SELECTOR CHARTS

LOVEJOY FLEXIBLE COUPLING CO.
5093 WEST LAKE STREET CHICAGO 44, ILLINOIS
Also Mfrs. Lovejoy Universal Joints and Lovejoy Variable Speed Transmissions

The basic model of the new unit handles 2,500-lb, 48-in. long loads. There are two mast heights, 68 in. and 83 in. The former provides 102½ in. of telescopic lift and the latter 132½ in. Other models are available to handle equally long loads weighing up to 4,000 lb.

The operator of the Transveyor stands on a non-skid safety plate at the rear of the truck, and is protected by a sideguard. He steers with his left hand, and operates other controls with his right hand. To release the brake, he presses the foot pedal, which also controls first speed. Second and third speeds are governed by a push-button on a hand grip control. The truck can be built with all three speeds controlled either by hand or foot, or any combination of the two.

The battery employed is standard for many of Automatic's trucks; thus batteries can often be shifted from one unit to another, and the same charging equipment can be used. In the "Transveyor," the battery can be removed easily from either the top or the side. Ample room is allowed so the battery cover can be lifted, permitting the battery to be charged in the truck.

A full inch of clearance is provided between each of the out-rigger arms and sides of the pallet. Experience shows this clearance is required for easy maneuverability.

Controlled plugging, good visibility for the driver, cold drawn alloy steel uprights, and dead-man control are other Transveyor features.

The unit is 29⅞ in. long, plus load length. It lifts a 2,500-lb pallet-load 20 fpm, and has a horizontal speed when loaded of four miles an hour. It is available in either telescopic or non-telescopic versions.

LUBRICATOR

▲ "Oil-Mist" lubricators with one-gallon oil reservoirs and built-in automatic warning switches which signal the operator by horn and red light, or shut off the machine as the oil level becomes too low, have been announced by the Alemite division of Stewart-Warner Corp. The units with 12-oz reservoirs are also now available with built-in warning switches.

Introduction of these new "Oil-Mist" models further reduces de-

YOUNGSTOWN ALLOY CASTING CORP., • YOUNGSTOWN, O.

ROLLING MILLS: bar, hoop, strip, shape mill guides, and rollers. SEAMLESS TUBE MILLS: guide shoes, rolling mill plugs and rolls, piercer points, etc. ELECTRIC WELD TUBE MILL: forming rolls, planishing rolls, tool holders, etc. • STRAIGHTENING MACHINE GUIDES • HEAT RESISTING CASTINGS

Maybe your business isn't LUMBER . . .

. . . or PINEAPPLES

BUT . . . just imagine the savings you could make, the problems you could solve by handling your materials with ROSS Straddle Carriers, the most flexible and most adaptable mass material handling method known!

ROSS engineers will be glad to work with your materials handling men in exploring the possibilities of ROSS Straddle Carriers for your operations . . . there's no obligation.

Send for details on ROSS Straddle Carriers . . . 10,000 lb., 20,000 lb., 35,000 and 45,000 lb. capacities.

Rely On ROSS

THE ROSS CARRIER COMPANY

Direct Factory Branches and Distributors throughout the world.

400 Miller St., Benton Harbor, Michigan, USA

pendence on the human factor in automatic lubrication. Previous models, through employment of a solenoid switch, gave lubrication when the machine on which they were used was in operation, but had provision only for visual measurement of oil remaining in the reservoir. The gallon size reservoir cuts frequence of filling and the signalling device makes it impossible for the unit to run dry accidently.

Two models of these units with gallon reservoirs are available. One, Model 4958, is wired with a normally open switch which makes contact when the level of the oil goes below 23 ounces. The switch sets off an immediate warning by red light and/or horn. Model 4859, the other model with gallon reservoir, has a closed switch which breaks contact when the oil level goes below 23 ounces and shuts off the machine.

Two new models of these lubricators with 12-ounce reservoirs having low-level signalling devices are also available. Model 4960 shuts off the machine as the oil level drops, while Model 4961 either sets off a warning horn or flashes a red light when oil falls to the two-ounce mark in the reservoir.

INVERTER

▲The development of a synchronous inverter, having a sensitivity of 0.05 microvolts and a dissymmetry of less than one-half of one per cent has been

announced by Bristol Co. Known as the "Syncroverter" switch, this inverter is capable of converting low-power d-c signals, as low as 0.05 microvolts, to alternating voltages that can be amplified and applied to electronic, electrical and servo systems.

The switch will operate at any frequency from zero to 3500 cycles. It is designed for precision use in electronic computors, instruments, gun directors, null detectors, and many other similar missiles. Instantaneous

A BIG LIFT for America's Steel Production

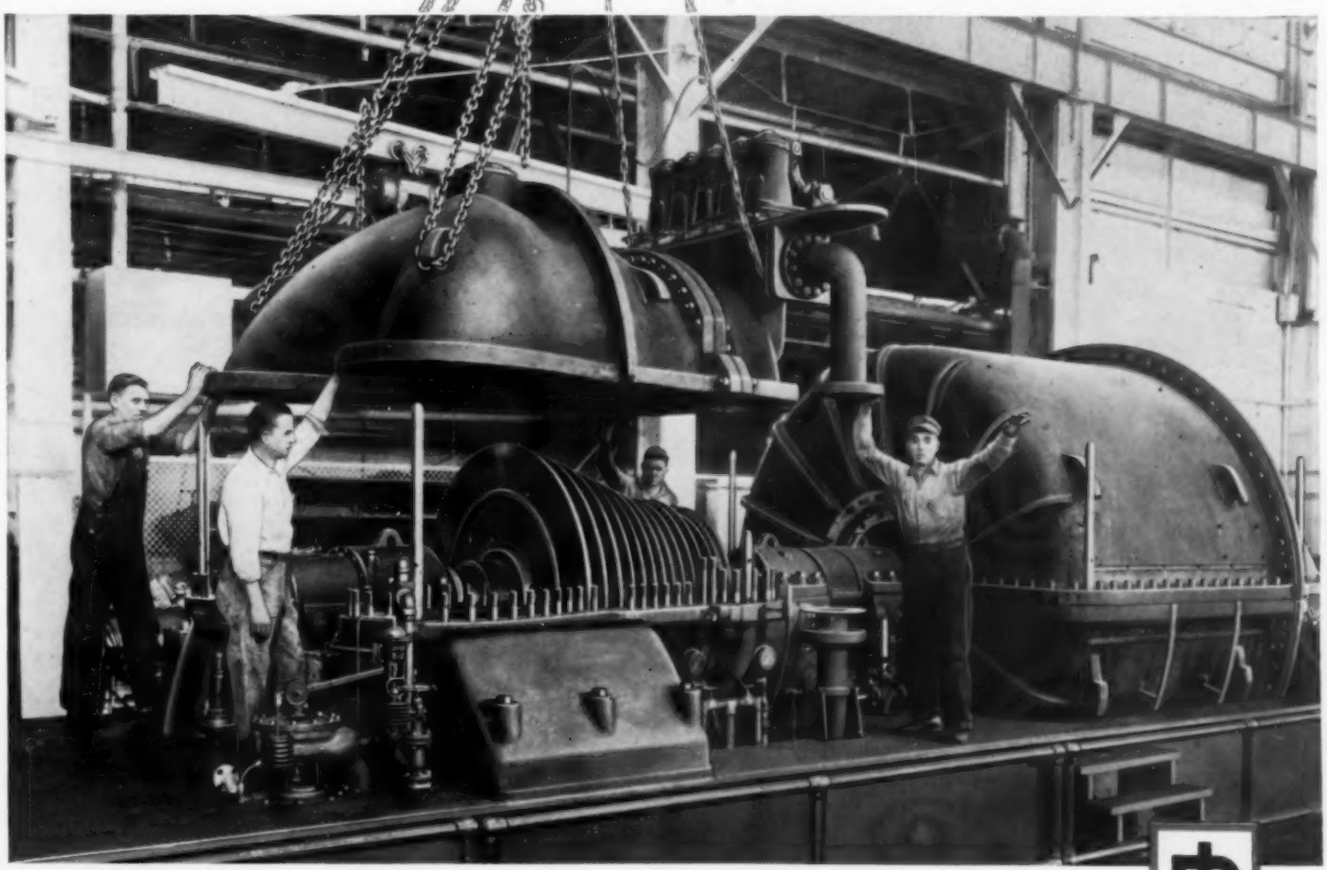
Three huge I-R Blast Furnace Blowers for U. S. Steel's new Fairless Works will help boost annual steel output by 1,800,000 ingot tons

In the photo below, a 12-ton turbine casing is being lowered into place on one of the three Ingersoll-Rand Turbo-Blowers for U. S. Steel's new Fairless Works at Morrisville, Pa. Each of these machines will have a capacity of 125,000 cubic feet of inlet air per minute against 35 psig.

Each of these five-stage centrifugal compressors is driven by a 15,750 horsepower steam turbine designed and built by Ingersoll-Rand for this specific service. They will normally operate on steam at 850 psi and 900°F. but will be suitable for operation on maximum steam conditions of 850 psig, 925°F.

The blast furnaces at Fairless are 110 ft. high and 28 ft. in hearth diameter. Each will be tapped five times a day, yielding around 300 tons of pig iron at a tapping—1,800,000 ingot tons per year.

For further details on I-R blowers or other I-R equipment, contact your nearest Ingersoll-Rand representative.



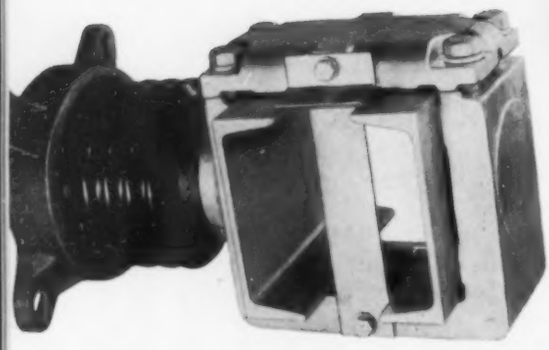
COMPRESSORS • AIR TOOLS
ROCK DRILLS • TURBO-BLOWERS
CONDENSERS • CENTRIFUGAL PUMPS
DIESEL AND GAS ENGINES

810-12

Ingersoll-Rand

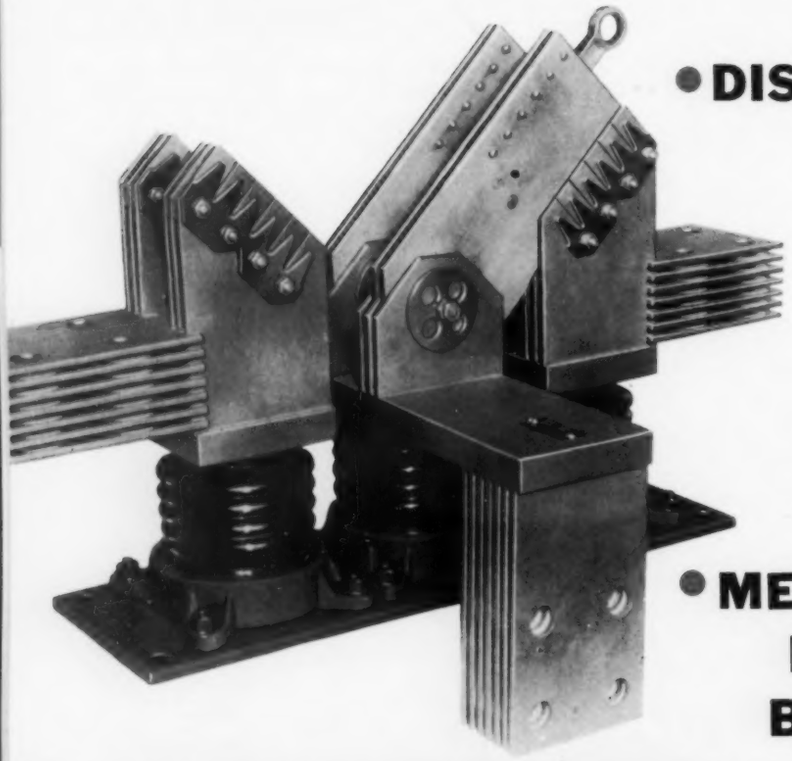
11 BROADWAY, NEW YORK 4, N. Y.

CHECK the FACTS on R&IE



• BUS SUPPORTS

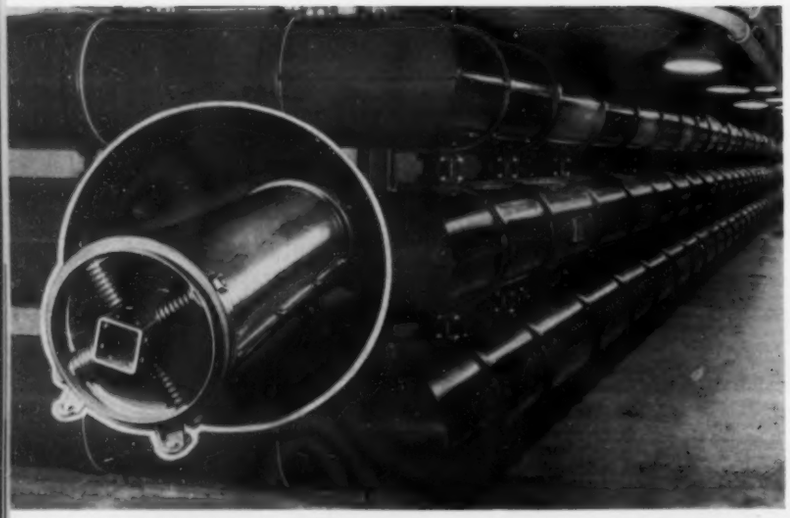
clamping two sections of five inch aluminum channel bus. Also designed for bus bar or cable support. Can be mounted in any position. Bus hardware attached with resilient alloy in place of cement — eliminating spot loading.



• DISCONNECTING SWITCHES --

double throw, 5,000 ampere rating. Blades are equipped with Hi-Pressure Contacts at operating end and at the hinge. Hi-Pressure Contacts make clean and positive electrical and mechanical current connections, and provide easy operation, free from sticking or freezing.

• METAL ENCLOSED ISOLATED PHASE BUS STRUCTURES



have sealed individual housings that prevent interphase short circuit. Support rings, as shown in circle, equalize all stresses. Covers can be removed for inspection or alterations. Especially suitable for heavy bus runs where mill dust and contamination is a problem.

Conductor can be round, square or bar.

Write for further details

RAILWAY AND INDUSTRIAL ENGINEERING CO., Greensburg, Pa.

Sales offices in all principal cities

An I-T-E Subsidiary

The Check List

HORN GAP SWITCHES

CONDUCTOR SUPPORTS CLAMPS AND FITTING

DISCONNECTING SWITCHES INDOOR AND OUTDOOR

INTERRUPTER SWITCHES

CUTOUTS AND THERMO-RUPTERS

DISTRIBUTION EQUIPMENT

SWITCH OPERATING MECHANISMS

SUBSTATIONS

OPEN OR ENCLOSED ISOLATED PHASE HEAVY DUTY BUSES

KIRK INTERLOCK SYSTEMS

AUTOMATIC SWITCHING EQUIPMENT

METAL CUBICLES

TESTING DEVICES

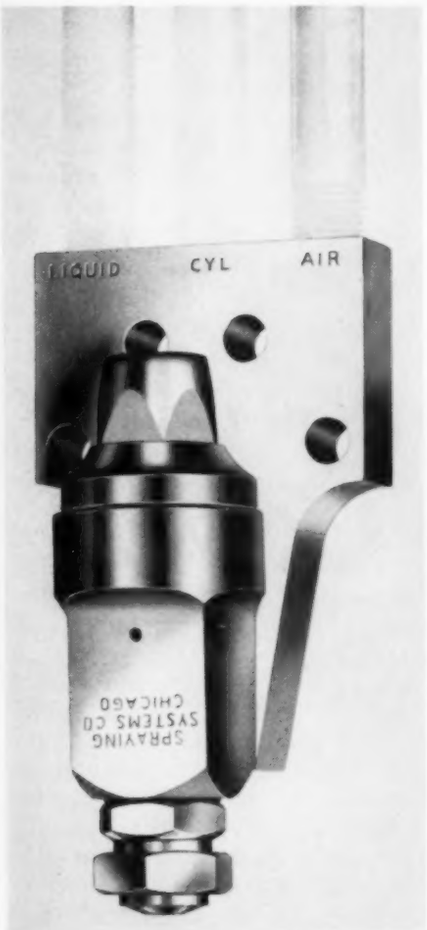
operation and length of life are not affected by vibration or shock.

Errors due to thermal emf are eliminated by the use of two single-pole double-throw contacts. The contact-carrying armatures are of such low mass that their mechanical response is practically instantaneous. The inverter is free from resonance effects. It is hermetically sealed against dust and corrosion.

The switch is also furnished with two separate and independent single-pole double-throw contacts for use, for example, on the input and output of a d-c amplifier.

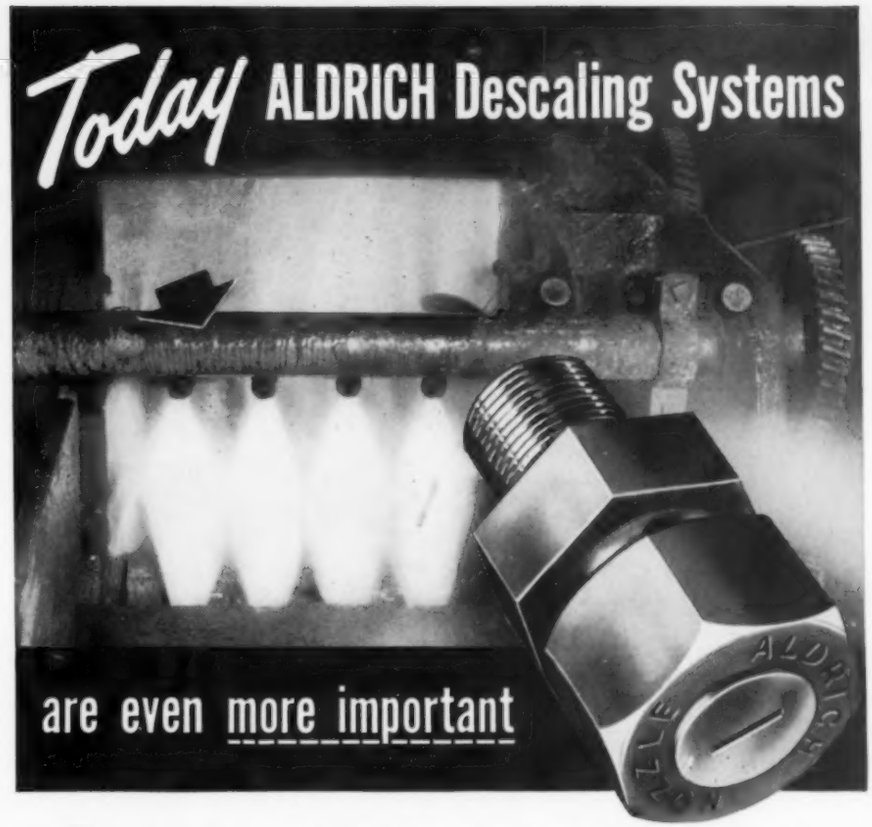
ATOMIZING NOZZLE

▲Users of pneumatic atomizing nozzles on production machines will be interested in the time savings afforded by the new plate mounted nozzles offered by the Spraying Systems Co. These nozzles are identified as the



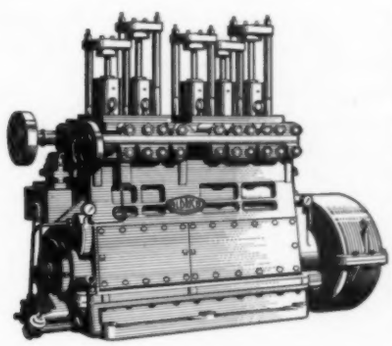
"JAU-PM" automatic pneumatic atomizing nozzles, and are supplied in full range of pressure and siphon set-ups.

These nozzles are designed for intermittent operation in any frequency or cycle desired. Operation



Because the metal industries *need* peak production. And when it comes to descaling—an *Aldrich* system is the quickest means of getting the finish required.

Aldrich Spray Nozzles employ a Venturi tube, embodied in the body and disc, to direct flow through a *rectangular* orifice. This produces a knife-edged *line* of water with an impinging force equal to 95% of the potential energy supplied to the orifice. The sharp jet and the striking force developed by Aldrich nozzles give far more effective descaling than jets of equal force but with a larger impinging area, produced by more water at lower pressure . . . Aldrich Spray Nozzles are available from stock. *Write for Data Sheet 61-2.*



The Aldrich Pump for your system may be a Direct Flow Triplex or other Multiplex unit . . . fitted with Aldrich Patented Synchronized Suction Valve Control, or Automatic By-Pass Valve to operate with all types of accumulators. For your *complete* Descaling System, or for pumps for roll balancing or press operation: call on Aldrich! Write today for Data Sheets on equipment.

THE ALDRICH PUMP COMPANY

21 PINE STREET, ALLENTOWN, PENNSYLVANIA

. . . Originators of the Direct Flow Pump

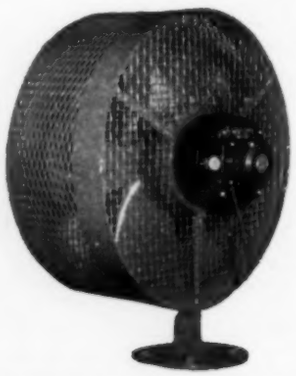
Representatives: Birmingham • Bolivar, N. Y. • Boston • Buffalo • Chicago • Cincinnati Cleveland • Denver • Detroit • Duluth • Houston • Jacksonville • Los Angeles • New York Omaha • Philadelphia • Pittsburgh • Portland, Ore. • Richmond, Va. • St. Louis • San Francisco Seattle • Spokane, Wash. • Syracuse • Tulsa • Export Dept.: 751 Drexel Building, Phila. 6, Pa.

and shut-off are instantaneous under air pressure control. In this type of nozzle the liquid, atomizing air, and control cylinder air connections are made permanently to the plate. The nozzle and plate are made with precision fit, with the nozzle held in place by a single lock nut. Removal of the nozzle requires only freeing of the nozzle by a few turns of the lock nut.

Typical application of the nozzle is in the automatic production lubricating of drinking glass molds. Sixty-five molds per minute per nozzle are lubricated on production lubricating machines, installed as part of an overall production line. Operation of the machines is twenty-four hours a day, with the nozzles positioned in an area of highly elevated temperatures. Whenever a nozzle needs servicing, removal and replacement can be made by the operator in a matter of seconds. In this application, easy removal also results in safety for the operator; former methods of nozzle installation where lines connected directly to the nozzle, made it difficult to remove the nozzle and often resulted in hand and arm burns for the operator.

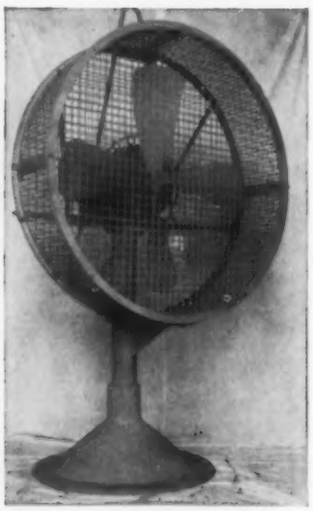
These nozzles are recommended for any application where intermittent nozzle operation and easy nozzle removal are desired.

IS HEAT SLOWING UP YOUR WORKMEN?



TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 in. sizes.

Keep them COOL with TRUFLO FANS



TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

Production suffers when workmen are overheated. Steps begin to drag, efficiency falls.

Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

PORTABLE COOLING FANS
CRANE CAB FANS • WALL FANS
EXHAUST FANS • BLOWERS
ROOF VENTILATING FANS
PENT HOUSE FANS

TRUFLO FAN COMPANY

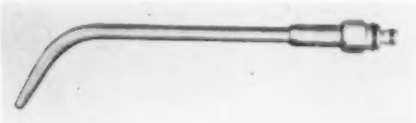
245 MAIN ST., HARMONY, PA.

WELDING HEAD

▲ A series of thirteen new welding heads for welding and heating work on practically any metal from 32 gage to more than 1 in. in thickness, is announced by Linde Air Products Co., a division of Union Carbide and Carbon Corp.

The new heads fit interchangeably on "Prest-O-Weld W-121 and W-122" welding blowpipes. All heads are of the snap-in type, and are attached to either blowpipe handle by means of a hand-tightening connection nut. Since no wrench is needed to get a firm, gas tight seal, head changes take only a few seconds.

Two synthetic rubber "O" rings on each mixer make possible the use of timesaving snap-in type heads. The long-wearing "O" rings are inexpensive and easy to replace.



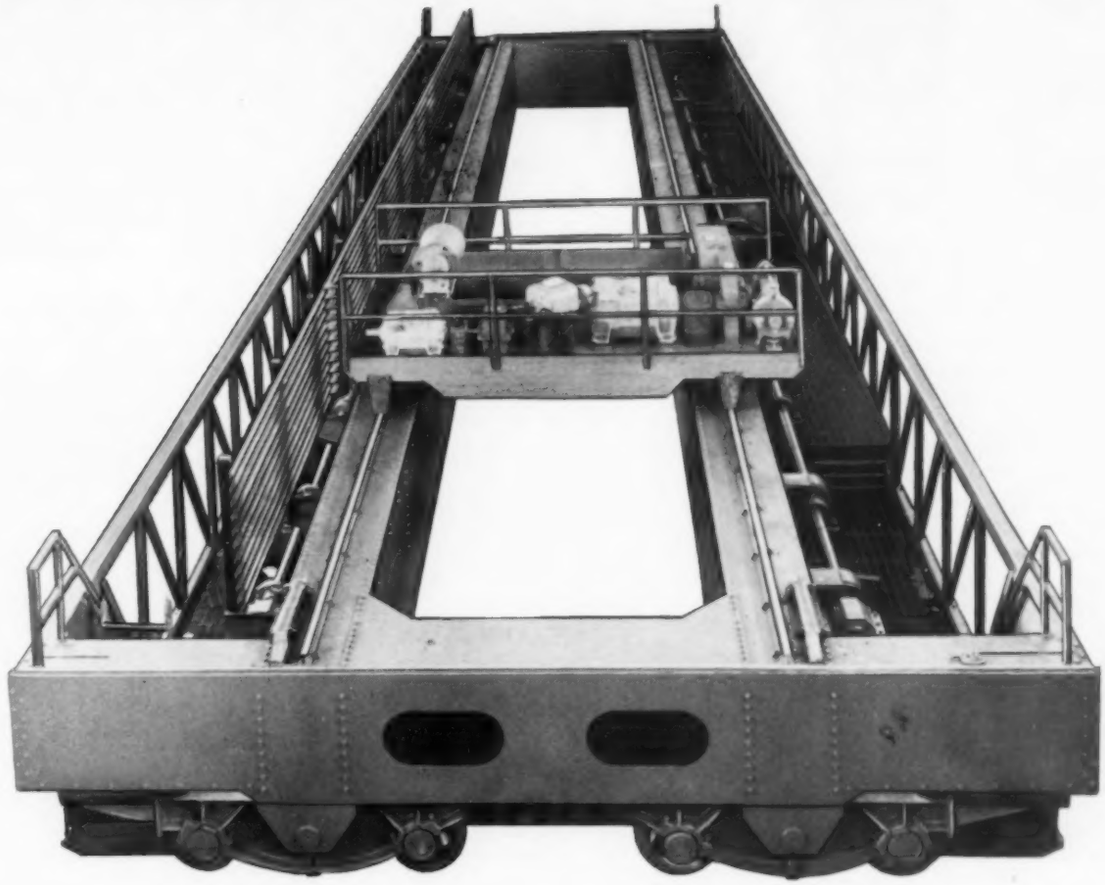
Head sizes are spaced so that welding ranges overlap. Practically any job, therefore, can be done with either a soft, low-velocity flame, or a hard, high-velocity flame. Size numbers, from 2 to 100, are stamped on each head. They indicate the flow rate, in cu ft per hour, of oxygen and acetylene when heads are used at recommended operating pressures. Knowing the flow rate makes it easy to estimate gas consumption for any job.

Once connected to the front of a blowpipe, the heads can be turned on the handle to point in any direction. This is especially convenient when working overhead or in hard-to-get-at places.

PYROMETER ACCESSORIES

▲ Several new developments in pyrometer accessories have been announced by the Industrial Division

TO A.I.S.E. SPECIFICATIONS . . .



Since the issuance of the new A.I.S.E. specifications for Steel Mill Cranes, "Shaw-Box" has developed and built a considerable number of cranes to these specifications. A typical interpretation is this 25 ton capacity, 100' 0" span single hook crane with double auxiliary girders, rigid end ties, and double A-5 bridge drive. The sturdy trolley includes oil-tight integral gear cases, pedestal bearings integral with the totally decked and toeboarded frame, sheave supports mounted above the frame with sheave assembly removable as a unit, and accessibility of all parts for easiest maintenance.

The proven experience, careful workmanship, and advanced engineering techniques that are basic in all "Shaw-Box" Crane construction insures dependable crane service with minimum maintenance under the most severe operating requirements.

"Shaw-Box" has designs to A.I.S.E. specifications for the popular sizes and types of mill cranes, together with the different variable optional units preferred by individual mills. To meet specific applications, "Shaw-Box" Cranes built to A.I.S.E. specifications are thus more readily available, and at attractive prices.

BE SURE TO SEND ALL YOUR INQUIRIES FOR STEEL MILL CRANES AND SOAKING PIT CARRIAGES TO "SHAW-BOX".

MAXWELL MANNING MOORE INC. TRADE MARK

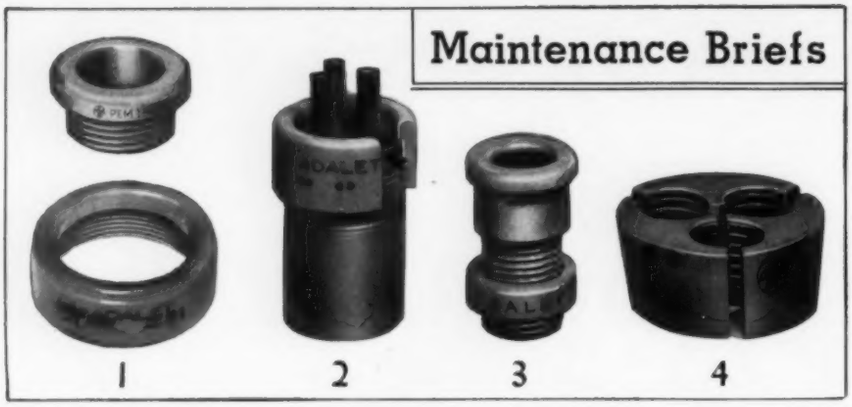
"Shaw-Box" CRANES

MANNING, MAXWELL & MOORE, INC.

Muskegon, Michigan

Builders of "Shaw-Box" Cranes, 'Budgit' and 'Lead-Lifter' Hoists and other lifting specialties. Makers of 'Ashcroft' Gauges, 'Hancock' Valves, 'Consolidated' Safety and Relief Valves, and 'American' Industrial Instruments.

Maintenance Briefs



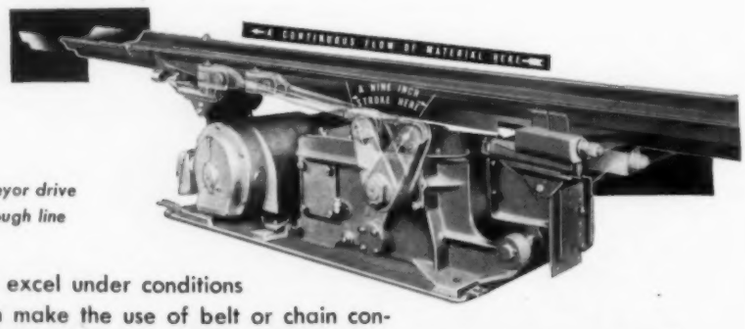
Electrical maintenance problems harrass every industry and take a big bite of the maintenance budget. Proper insulation is a vital factor in reducing these problems to a minimum. To insure this, The Adalet Manufacturing Company of Cleveland, Ohio, offers these suggestions: (1) "Sali" insulating bushings on every conduit terminal to cut future maintenance, eliminate grounds and shorts. "Sali" bushings are made with undercut shoulder for space-saving installations. Strong, resilient laminated phenolic material. (2) Conduit terminators, versatile end fittings with special "Sali" insulating body and a sandwich of two "Sali" discs with neoprene between. Used on cranes or machinery to dampen out vibration of cables, or to seal the ends of conduits. (3) Mill motor insulating bushings, made in a range of sizes to cover the hole sizes and frame thickness of mill motors. These "Sali" phenolic bushings replace troublesome rubber grommets as each motor is taken out of service for maintenance. (4) Vertical support "Wedgelocks" that can be driven into existing iron bushings. No need to disconnect cables. Made of canvas base "Sali" material. Will not warp or split. For details write to

THE *Adalet* MANUFACTURING COMPANY
14300 LORAIN AVE. • CLEVELAND 11, OHIO

NEW! GOODMAN SHAKER CONVEYORS

offer a practical and economical method of moving hot and abrasive materials.

Whatever you want to move — coke, sinter, steel scrap, castings, silicon carbide, mill scale, dolomite, bauxite, or other hot, abrasive material — it will pay you to investigate Goodman's specially designed shaker conveyors.



Shaker conveyor drive unit and trough line

They excel under conditions which make the use of belt or chain conveyors impractical. Small tonnages or large tonnages are moved with ease, for short or long distances — upgrade, downgrade, or on the level.

Every Goodman Shaker Conveyor installation is engineered to suit its specific application.

GOODMAN MANUFACTURING COMPANY
Industrial Manufacturing Division
Halsted Street at 48th **Chicago 9, Illinois**

of Minneapolis-Honeywell Regulator Co. Among the new numbers the company reported three new types of insulated thermocouple wires and a new screw cover thermocouple head.

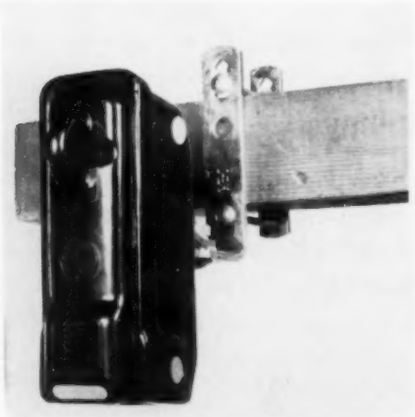
The new wires are for sub-zero temperature measurements, for refrigeration and air conditioning work, engine test cell applications, and for food canning involving heat-penetration studies, the measuring of canning retort temperatures and others.

The latest wire additions include insulation made of plasticized vinyl chloride for ambient temperatures between 20 degrees below zero and 225 degrees above F, a non-impregnated glass for ambient temperature up to 1200 degree F, and a fibrous silica for ambient temperature up to 2000 F.

The new screw cover thermocouple head, for power generation, refinery, chemical, glass and ceramic plants, will not freeze or rust. It can be used for single or duplex thermocouple or high-resistance thermometer elements.

HEAVY DUTY CUTOUT

▲ New heavy duty cut-outs, rated 5.2 kv, 100 and 200 amperes, with higher interrupting ratings have been announced by the General Electric Co.'s distribution transformer department.



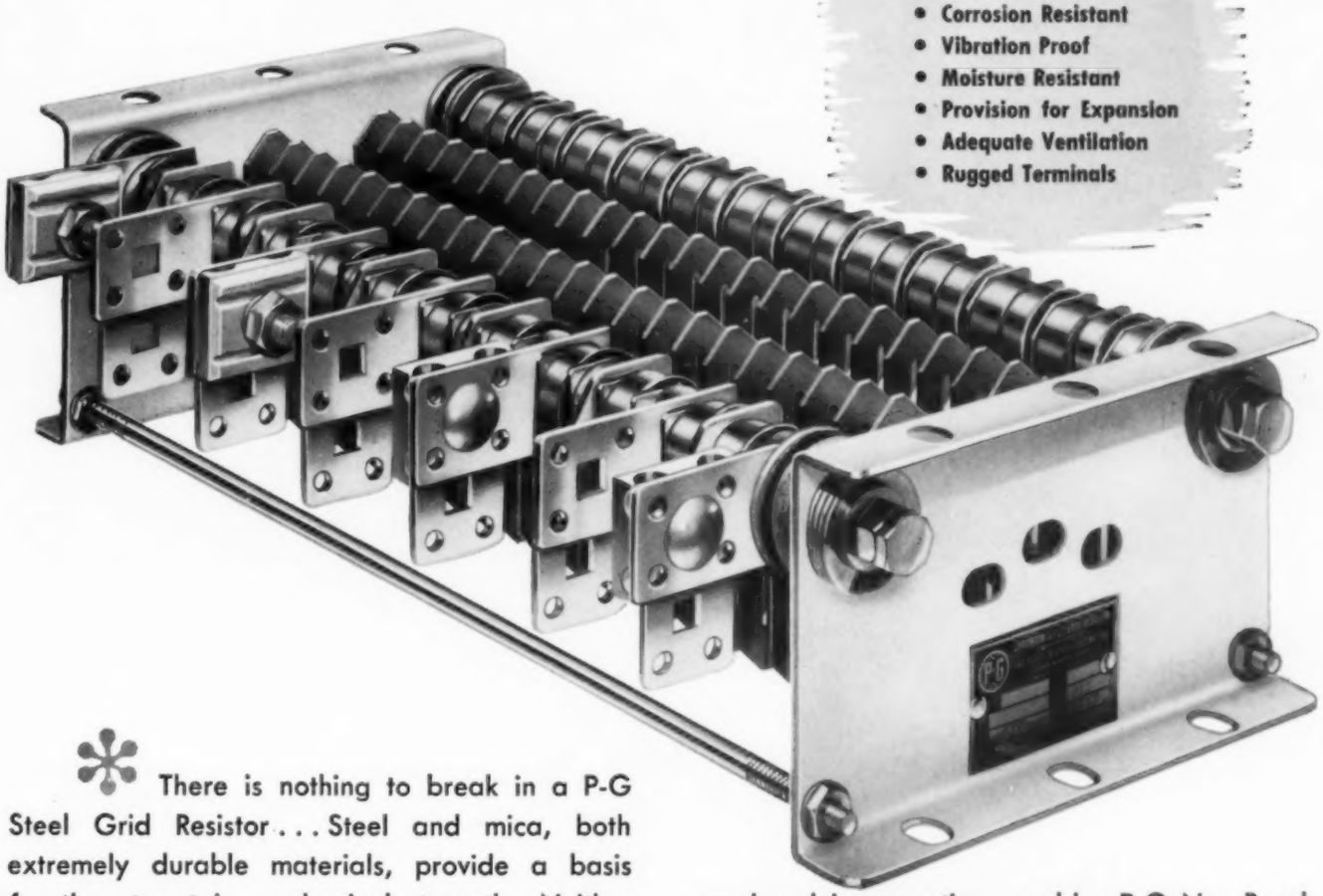
These new cut-outs will interrupt short-circuit currents of 8000 amperes at 5 kv and 12,000 amperes 2.5 kv. Interrupting ratings of the superseded cut-outs were 8,000 amperes at 5 kv and 5000 amperes at 2.5 kv.

The new 100-ampere heavy duty cut-out can be distinguished from standard duty cut-outs by the reflector on the cut-out door. Day or night, this reflector is visible from the ground.

BUILT OF *Steel* AND *Mica*

NOTHING TO BREAK . . .

- Steel Construction
- Mica Insulation
- Corrosion Resistant
- Vibration Proof
- Moisture Resistant
- Provision for Expansion
- Adequate Ventilation
- Rugged Terminals



There is nothing to break in a P-G Steel Grid Resistor . . . Steel and mica, both extremely durable materials, provide a basis for the utmost in mechanical strength. Neither do vibration, nor moisture laden or corrosive atmospheres have material effect on P-G Resistors . . . This, together with provision for expansion as well as efficiency in dissipating heat produced in operation, enables P-G Non-Breakable Resistors to give long and trouble-free service . . . The next time that troublesome application is at hand, specify P-G and solve your maintenance problem.

Write for Bulletin No. 500

P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

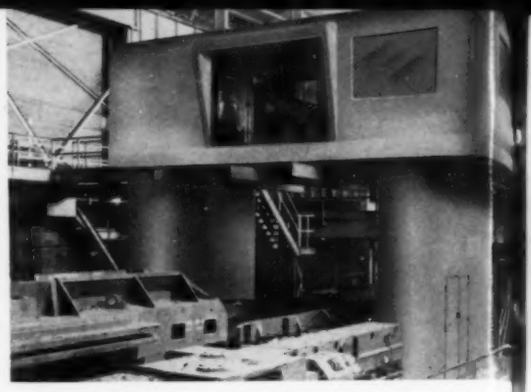
MILL PULPIT

▲ James Campbell Smith, Inc., has announced modern mill operator's pulpits for installation in new mills and for replacement in existing mills. Every pulpit is engineered to fit the particular job.

These modern pulpits offer many advantages, resulting in improved mill production and better personnel relations. Streamlined design provides rounded corners—outside and inside—thereby eliminating the hazards of sharp angles.

The columns are shrouded, with all wiring concealed yet readily accessible through conveniently located doors and other openings. Walls consist of heavy steel panels thickly insulated to resist heat.

The windows at the front are inclined for best possible operating vision. Thick, shock-resisting glass provides protection for operator against flying particles of steel or other objects. Steel beams can be provided under floor to allow for monorail installation.



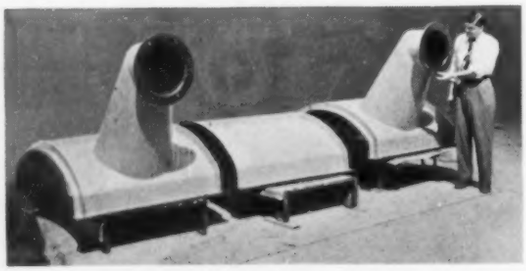
All features of these pulpits have been carefully planned for utmost operating efficiency—acoustical ceilings, non-slip floors, indirect lighting, toilet, lavatory, lockers, and desk if needed. Furthermore, air conditioning may be included so that regardless of ambient temperature the pulpit can be kept at a comfortable 80 F, summer and winter, and supplied with healthful, filtered air, free from dust.

Walls are constructed of 4 in. thick rockwool insulation, up to ¼ in. plate outside with 14 gauge to ⅛ in. inside, rounded corners, welded joints, minimum of through metal for low heat conduction and sound deadening, heavy steel doors with door closers, acoustic ceilings, all 100 per cent fireproof. Floors are non-skid steel or composition. Platforms, walkways and stairs are included.

Pulpits are shipped completely assembled with crane lifting eyes, making installation a matter of hours.

FOR MAXIMUM PROTECTION

From Corrosive Fumes and Liquids



Pickling Tank covers fabricated and lined for high temperature service with Neoprene Sheet Rubber in Heil Cleveland plant.

Specify HEIL Lined Equipment!

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- KOROSEAL
- SARAN RUBBER
- LEAD
- PLASTIC

Steel Pipe Lined with Neoprene Rubber for Temperature and Corrosion Resistance.

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• You are assured longer service life and less maintenance cost by our expert workmanship and unbiased selection of the best lining materials for your specific requirement.

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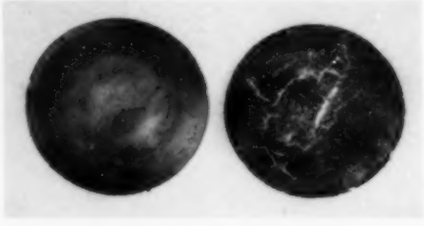
HEIL PROCESS EQUIPMENT CORP.

12901 Elmwood Ave. **Cleveland 11, Ohio**

Other Heil Products Include: Lined Pickling Tanks • Acid-Proof Maintenance Materials Lead Fabrication • Steam Jet Agitators • Monel Crates and Hooks • Lined Steel Pipe

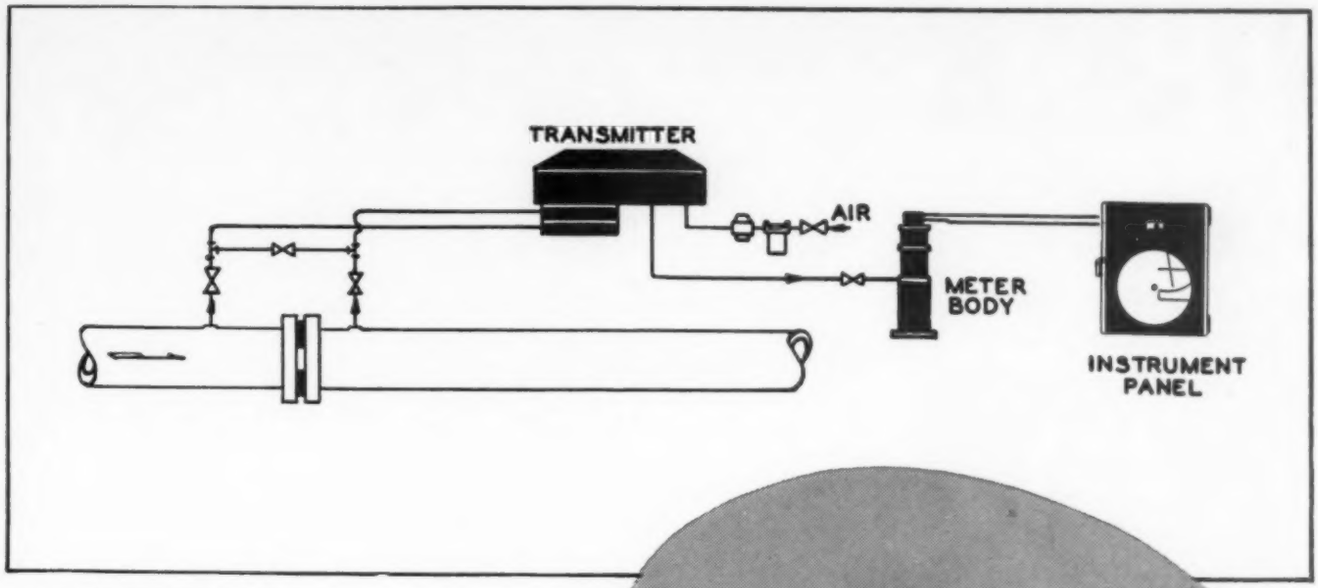
RESIN CEMENT

▲ An entirely new and vastly improved resin used as a chemical resistant cement which not only provides higher tensile strength and less shrinkage, but also provides improved resistance to oxidizing solutions



with better water and thermal stability, has just been announced by the Irvington Varnish and Insulator Co.

This new resin, known as "Fura-Tone 1347," will not crack, check or



Republic Pneumatic Electric Metering System

DESIGNED ESPECIALLY for YOU Mr. Steelmaker to Measure Blast Furnace and Coke Oven Gas Flow

We had your problems in mind when we designed the Pneumatic Electric Flow Meter. We know a steel mill is a dusty place; it can't be otherwise and do a good job making steel. We know the gases produced in a steel mill are dirty. So, to help you steel mill people keep track of what is going on inside your maze of pipes, furnaces and ovens, we designed a meter that could operate in dusty surroundings and accurately measure flow of dirty gases without frequent maintenance. Yes, we engineered the dirt right out of the meter.

Here's How:

KEEPS DIRT OUT

The Pneumatic Electric Flow Meter uses a differential pressure transmitter to isolate dirty gases from direct contact with mercury in meter body. Transmitter establishes an air loading pressure that is directly proportional to flow differential. The measuring chamber of the transmitter is small and has practically no change in volume when differential pressure changes. Thus, dirt in the gas is not sucked into the chamber to cause the diaphragm to stick or clog.

DOUBLY DUST SEALED

Rugged boiler meter case completely encloses reading instruments which are individually sealed. Double seal prevents dirt from getting in to foul or clog parts and cause inaccuracies or failure.

REMOTE READING INSTRUMENTS

Meter body responds to air loading pressure changes from transmitter and produces proportional electrical variations which are transferred to remote reading instruments. Integrator and recorder operate independently — may be separated to suit individual requirements.

OVER-ALL ACCURACY

Differential pressure transmitter is extremely sensitive to pressure changes, however rapid. Mercury in meter body has no work to do, only makes or breaks contact with resistance rods. Recorder permanently records rate of flow and time of flow changes. Integrator working on modified watt-hour principle *continuously* totalizes all flow, not just average of spot readings. Accurately follows all sudden changes in flow.

RANGE EASILY CHANGED

Differential pressure transmitter and meter body can be adjusted (many times right in the field) for almost any range.

CONTINUOUS METERING

Measurement and control of fluid flow is not interrupted by meter failure because Pneumatic Electric Flow Meter is built to give dependable, maintenance-free service. Working mechanism is accessible and easy to adjust. And remember—Republic has 28 branch offices throughout the country, so there's one near you to help you with your metering and control service problems.

Pneumatic Electric Flow Meter is also excellent for metering widely varying flows such as occur in oxygen scarfing operations.

REPUBLIC FLOW METERS CO.

2240 Diversey Parkway, Chicago 47, Illinois

IPM

ENDS COSTLY SHUT-DOWNS of motors and generators

IDEAL PREVENTIVE MAINTENANCE

protects you against shut-downs and high cost overhauls resulting from commutator and slip ring failure. IPM keeps motors and generators at peak efficiency . . . *without dismantling,* and with only simple, routine maintenance. It insures you of using the methods and equipment that have proved most practical and economical in eliminating commonly encountered commutator and slip ring troubles. IPM has improved operating dependability and efficiency—*and reduced costs*—at many of the nation's largest users of electric motors and generators. It can do as much for you!

Get this FREE handbook of practical help!

procedures and methods developed by independent authorities on commutator and slip ring maintenance. What to do and how to do it!

Forty pages, profusely illustrated.

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Please send your free maintenance handbook and further information on:

☐ Flexible Abrasive ☐ Resurfacers
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warp, such as is common with furfuryl alcohol resin. The resin also exhibits a notable improvement in shrinkage, according to the manufacturer.

This resin may be substituted for furfuryl alcohol resins for lining tanks, or as a cement for chemical bricks to obtain superior chemical and physical properties.

FORK LIFT TRUCK

▲ To meet the growing demand for diesel-powered units, yet retaining all the basic operating features of gas-driven equipment, Towmotor Corp., announces that four of their most popular fork lift truck models are now available with either gasoline or diesel engine. These are the LT-62, LT-60, No. 460, and 480-P.

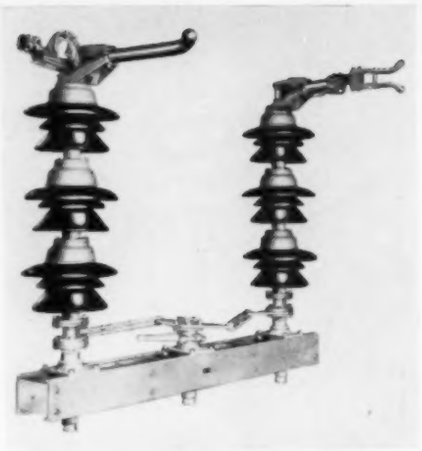
Extensive tests of the diesel engine selected for these Towmotor applications proved it capable of developing unusual power for its size and weight. Operating economy was also found to be exceptional, even under hardest prolonged service. In addition, the engine's highly simplified design assures minimum operating and servicing problems.

CENTER-BREAK SWITCH

▲ A new line of "PMK" horizontal center-break switches has just been announced by Delta-Star Electric Co., division of H. K. Porter Co., Inc.

These new switches incorporate a new contact assembly featuring independently sprung pressure-applying springs; a new bronze ball-bearing swivel terminal; and insulator bearings with non-rusting, double race, stainless steel ball bearings.

The "PMK-22" switch has a direct linkage connection between the two rotating insulators. The "PMK-23" has a center bearing with a toggle linkage between the two rotating insulators.



These new "PMK's" are available in all standard voltage ratings from 7.5 to 161 kv and in ampere ratings of 400 (up to 46 kv), 600 and 1200 amperes for upright and inverted mounting.

SAFETY CAP

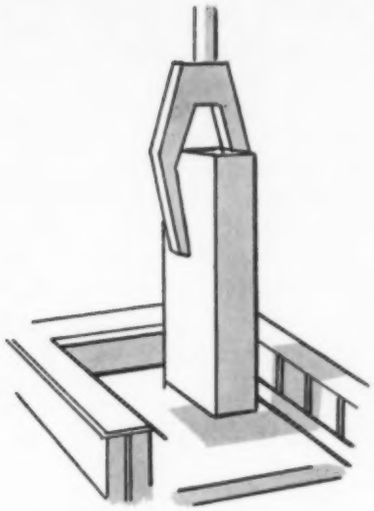
▲ A new type safety head covering, the hard boiled cap, features lighter weight, more air space and exceptional impact resistance.

Although it has a lower crown than any other safety hat or cap, the air space between the hammock and crown is ¼ in. in excess of the 1¼ in. required by safety codes. This permits free circulation of air and is consequently cooler for the wearer. The full-floating hammock and self-shaping sweatband also provide more comfort for the wearer because they distribute the light weight of the cap evenly over the entire head. Hammocks can be slipped on in six seconds with wedge type fasteners that hold tight.

The hard boiled cap which is distributed by Safety First Supply Co., is made in one size only that fits all heads. Headbands are quickly adjustable to head sizes from 6⅝ to 7⅞. The brim of the cap is shaped to form a raintrough. The crown is grooved along the top to hold the lamp wire in place; the raintrough serves the same purpose for lamps of other design.

On all tests—radiation, insulation, strength, inflammability, water absorption and aging, the hard boiled cap exceeded the most rigid requirements set up. Dielectric strength is high. Caps immersed in brine withstand application of 2000 potential for one minute.

What's YOUR Bulk Material Handling Problem?



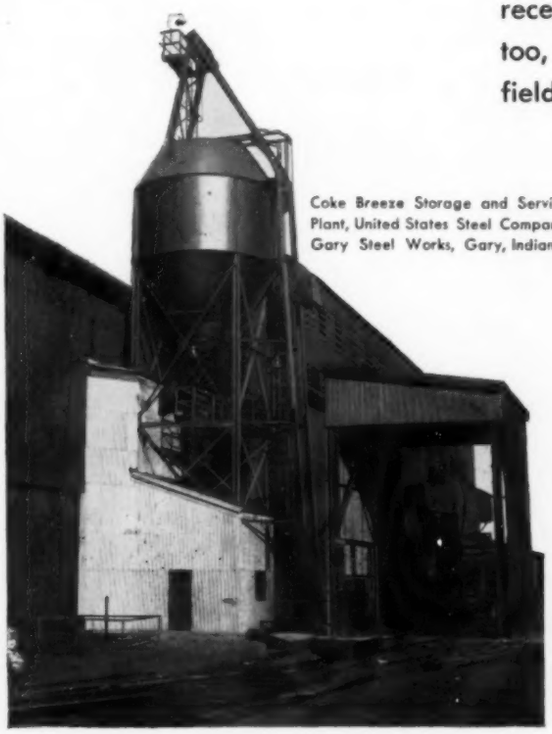
* COKE BREEZE
* DOLOMITE
* COAL
* SAND
* COKE
* OTHER BULK MATERIALS

When you have engineering and construction problems connected with handling and processing bulk materials, consult Roberts and Schaefer Company. It's best to call R&S engineers during early planning stages — but it's a profitable decision at any time, whether your plans are started or not.

We are equipped to engineer and erect any plant for storing and handling bulk materials, and for processing them too.

For more than 50 years we have been engaged in this specialized type of engineering and have designed and erected complete plants for the mining, railroad and allied industries.

To our long list of installations for coal preparation, for storing and processing coal, coke, sand, and other bulk materials, we recently have added plants for coke breeze and dolomite. Then, too, our present research into the sintering and ore reclamation field might also interest you.



Coke Breeze Storage and Service Plant, United States Steel Company Gary Steel Works, Gary, Indiana

Whatever your problem . . . phone or write us today — either at Chicago or one of our branch offices — no obligation of course.

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LOW LIFT TRUCK

▲Where heavy loads must be moved at high speed over long distances and in well ventilated areas, a gasoline powered low lift platform truck may be the answer. Elwell-Parker Electric Co. is the exclusive manufacturer of this type of low lift truck which is designed to complement their well known line of similar electric models. Steel mills, ceramic plants, foundries, docks, and warehouses, will find this low cost, rugged machine the answer to some of their materials handling problems.

Both 3 and 5 ton capacity models are available. They are end-control, stand-up type trucks, powered with a four cylinder gasoline engine driving a rugged worm and gear reduction unit through a disc clutch and two speed transmission. The load platform can be raised a distance of 5¾ in. by means of a hydraulic cylinder and a simple rocking link mechanism. Four wheel steering is provided for maximum maneuverability. The controls are similar to those of an automobile with the exception that the brake and clutch pedals are operated from the standing position.

The five ton model is equipped with dual sets of trial wheels under the load platform to support the heavy load. Dimensions of these trucks can be altered to suit special load handling requirements.

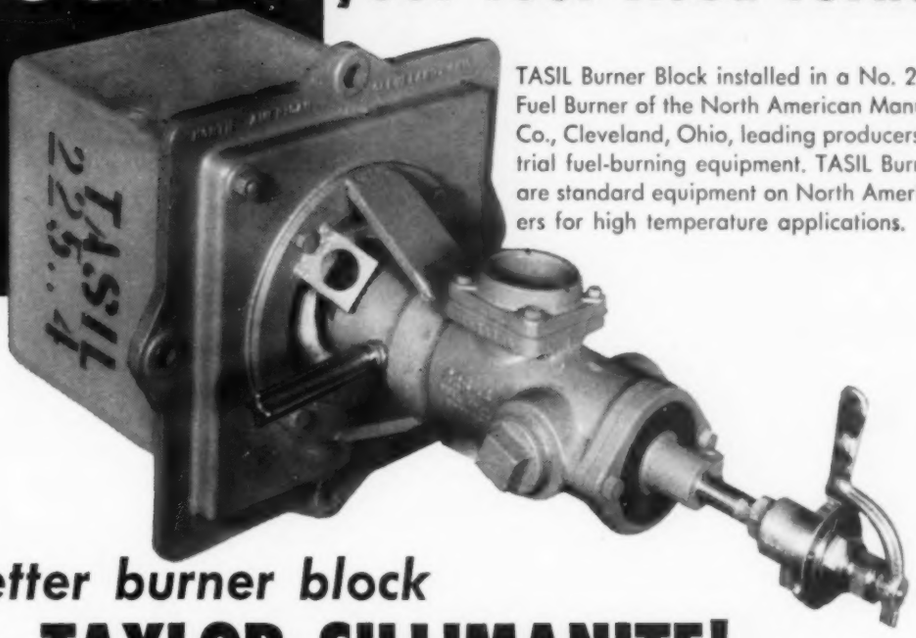
This type of truck is designed as a self-loading load carrier and permits handling all types of skids and skid boxes, as well as many special racks and other load supporting devices.

Powered by a four-cylinder gasoline engine, this new low lift truck features four-wheel steering and two-speed transmission.

INDUSTRIAL FAN

▲ A new, rugged industrial fan built with either an air handling, a materials handling, or a long shavings wheel is now available from the Sturtevant division of Westinghouse Electric Corp. The fan is made in 11 sizes with capacities ranging from 670 to 44,000 cfm and pressures up to 16 in. water gauge. The air handling wheel has backwardly-inclined blades featuring low power consumption over a wide range of volumes and pressures. It is particularly suitable for exhausting smoke, fumes and light dusts. The heavy-duty, straight-bladed, side-plated, materials handling wheel combines high fan efficiency with its material handling features. Conveying of sawdust, granular materials and chips are typical applications of this type of wheel.

The burner block is the heart of your fuel-fired furnace



TASIL Burner Block installed in a No. 225-4 Dual Fuel Burner of the North American Manufacturing Co., Cleveland, Ohio, leading producers of industrial fuel-burning equipment. TASIL Burner Blocks are standard equipment on North American burners for high temperature applications.

The better burner block is TAYLOR SILLIMANITE!

PRE-FIRED BURNER BLOCKS of Taylor Sillimanite (TASIL) are preferred by North American and a majority of leading furnace and burner manufacturers for high temperature applications. TASIL is specified because the block must hold original contour and dimensions. Compared to blocks made of fireclay or most other refractory materials, TASIL has superior resistance to shrinkage, cracking or spalling. TASIL further qualifies because it is inert in either oxidizing or reducing atmospheres; has higher fusion point and resistance to corrosion by most industrial slags. For longer service from your heating, annealing or forging furnaces, specify TASIL burner blocks.

In an emergency, when a burner block failure occurs at the time your stocks of pre-fired shapes are depleted, you can ram your own TASIL Burner Blocks, on the job, with one of several TASIL Ramming Mixes *engineered* for this application. Burner Blocks which may be cast or poured in molds, air dried and placed in service can also be made from TASIL Hydrocast—the hydraulic-setting castable for use to 3000° F. Data on TASIL Ramming Mixes are given in Bulletin No. 315 . . . on TASIL Hydrocast, Bulletin No. 313. Write direct, or contact your Taylor field representative, for your free copies.

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TAYLOR ZIRCON · TAYLOR SILLIMANITE

The **CHAS. TAYLOR SONS Co.**
A SUBSIDIARY OF NATIONAL LEAD COMPANY
REFRACTORIES SINCE 1864 • CINCINNATI • OHIO • U. S. A.

The long shavings wheel has no side plates and has been specifically designed for handling long, stringy fibers.

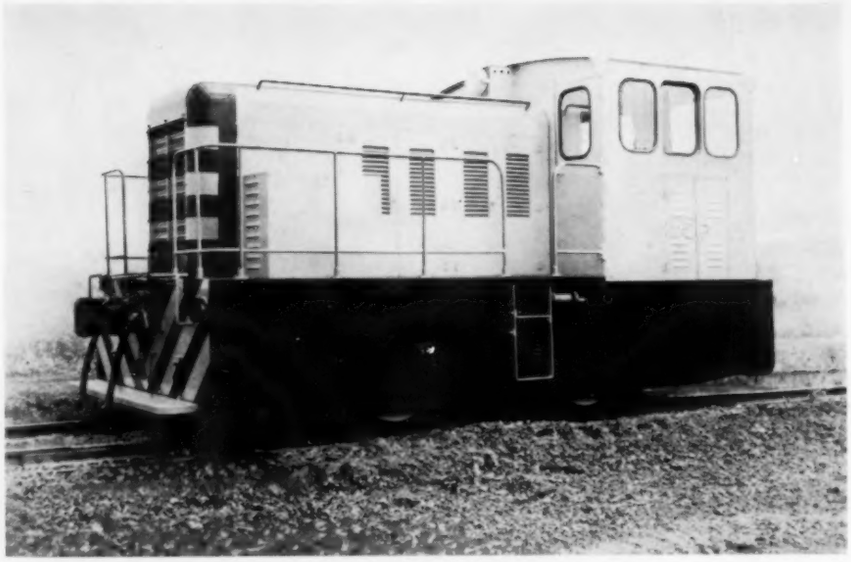
Standard accessories for the fan include both bolted and quick opening type access doors, flanged outlets and inlets, and outlet dampers. It is available with a variety of special coatings, and can also be built of special metals to meet explosion-proof or anti-corrosive specifications. For high temperature applications, special cooling accessories are available.

DIESEL-HYDRAULIC UNIT

▲ A diesel-hydraulic locomotive, built by Baldwin-Lima-Hamilton Corp., is a 35-ton, 190-hp unit designed specifically for industrial plant switching service.

Powered by a 6-cylinder, 4-cycle, supercharged diesel engine, rated 225 hp at 1800 rpm, the locomotive has a starting tractive effort of 17,500 lb at 25 per cent adhesion and 21,000 lb at 30 per cent. Built for track gages from 30 to 66 in., overall length is 17½ ft and wheelbase is 6½ ft.

Transmission equipment includes a twin-disc torque converter and clutch with two-speed transmission and an axle-hung reverse gear. Speeds are 10.6 and 28 mph. Underframe is all welded steel slabs and plates with pedestal tie bars bolted beneath journal box openings. Jour-



Designed specifically for industrial plant switching service, the new diesel-hydraulic locomotive built by Baldwin-Lima-Hamilton Corp. has a 6-cylinder, 4-cycle diesel engine and a starting tractive effort of 17,500 lbs.

You've got a Winning Combination

A STANDARD ISA FACE-TO-FACE DIMENSIONS
K "FLOW-LINE" CONTOURED BODY
Q STELLITED SEATING SURFACES
J RENEWABLE SELF-ALIGNING GUIDES
10 SEAT RINGS EASILY REPLACED WITH VALVE IN PIPE LINE

with the New

TRADE LESLIE MARK

DOUBLE SEATED DIAPHRAGM CONTROL VALVES

Calling a spade a spade you've got a "royal flush" of features in these new Valves designed for use with control instruments. With these Valves, you get as *standard equipment*, features heretofore only obtainable in expensive, specially designed valves.

Sectional view Class DV Double Seated Diaphragm Control Valve

ESTABLISHED 1905 LESLIE CO.

WRITE FOR Bulletin 513

4765

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HAVE *Strength* WHEREVER STRENGTH IS NEEDED

Satisfying A.I.S.E. specifications, Browning Mill Type Cranes incorporate types of motors and controls on which you have standardized. This flexibility suits your VRB crane *perfectly* to your needs. Our design, springing from 49 years' experience, places plenty of strength where it is required.

Ask for our Bulletin "E"

Husky 10-ton mill type trolley equipped with separate load girt for easy removal.

VRB

VICTOR R. BROWNING & COMPANY, Inc.

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COMPANY, INC.

dust free air
for motor rooms
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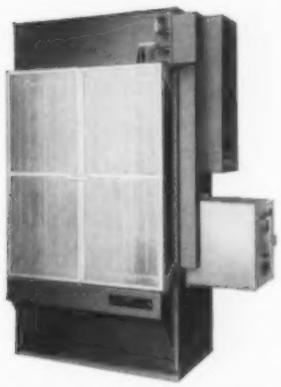
of blast furnace blowers.

Let us tell you how clean air can reduce shut-downs

AAF ELECTRO-MATIC

The only automatic electronic precipitator. The collector plates are automatically cleaned and reoiled every 24 hours thus maintaining highest efficiency at all times over a wide range of particle sizes . . . from smoke to largest airborne material.



ELECTRO-MATIC—electronic precipitator

AAF MULTI-DUTY

A fully automatic viscous air filter. Exclusive overlapping panel construction provides high efficiency, constant air volumes and positive self-cleaning.

MULTI-DUTY—automatic viscous filter

AAF

American Air Filter

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American Air Filter of Canada, Ltd., Montreal, P. Q. • Pacific Division Office, San Francisco, California

nal bearings are roller type. The tension of the heavy-duty roller drive chain, connecting axle assemblies, is adjustable by means of journal-box shims.

The hydraulic torque converter, equipped with an over-center throwout clutch, is mounted directly on the engine bell housing. Its infinitely variable torque multiplication feature provides smooth and gradual transmission of engine power to locomotive drive. It is impossible for torsional vibration or shock loads to be transmitted from engine to locomotive drive or vice versa, and its slipping characteristics eliminate engine stalling from overload.

The two-speed transmission provides a 1:1 ratio in high speed and a 2.69:1 reduction in low gear. Gear shift lever and throttle are interlocked to permit changing from one gear ratio to the other only at idle engine speed. The axle-hung, power operated reverse gear connects to the transmission output shaft by means of a sliding universal joint. Gears and shafts are of alloy steel mounted on heavy-duty roller bearings running in oil. Clutch and reverse transmission are air operated and electrically controlled.

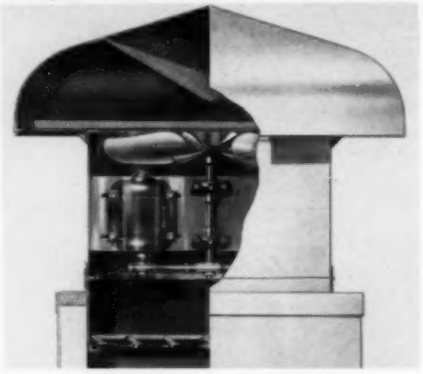
Electrical equipment includes a battery and charging generator for engine starting, lighting, etc. The air brake system is Westinghouse straight air type with SA-2 self-lapping brake valve. Braking is provided only for the locomotive, but is available for train-line at extra cost.

VENTILATOR

▲ Designed to meet modern architectural requirements for a highly efficient power driven fan ventilator that is low in height and of pleasing and inconspicuous design, Burt's new Low Type Ventilator is finding many new applications in industry.

Burt engineers have combined high capacity, weather-proofing, quietness and high efficiency with simplicity of installation in the new unit. It may be used with equal efficiency either as an exhaust fan ventilator or as a fresh air supply unit.

Burt Mfg. Co.'s low type ventilator can be supplied with either a direct motor-driven fan or with a V-belt and pulley drive. Sizes range from 12



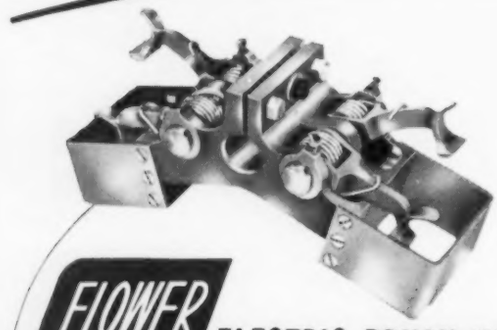
in. to 60 in. fans. Standard construction is prime galvanized steel but other material, such as aluminum, stainless steel, etc., may be employed for special purpose use.

AIR SYSTEM MAINTENANCE

▲ Compressed air, as emphasized by its increased use, has proven itself among the foremost production power media.

Maximum benefits are being obtained by those who keep a close

Important!



FLOWER ELECTRIC BRUSH HOLDERS ARE JOB-DESIGNED

• Here is a double tandem brush holder specially designed for The Yoder Company's 4400 KVA welder—a typical example of Flower job-design and production. Discover how Flower brush holders save maintenance time and money. Get the facts!

SEE OUR EXHIBIT— BOOTH NO. 450

Iron & Steel Engineers Exposition

Write for Catalog

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Our engineering department will gladly collaborate with yours in achieving desired results.

180° FRESNEL FLOOD for BOUNDARY LIGHTING

CODE BEACONS and OBSTRUCTION LIGHTS

300 to 1500 WATT ELIPTOR FLOODS

SEARCH LIGHTS

HINGED FLOOD POLES

FULL LINE OF ENCLOSED FLOODS

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INDOOR & OUTDOOR LIGHTING FOR EVERY NEED

Wellman will build it

Special Cranes
Coke Pushers
Gas Producer Plants
Ore Bridges
Charging Machines
Forging Manipulators
Gas Flue Systems
Gas Reversing Valves
Mine Hoists
Skip Hoists
Clamshell Buckets

→ Wellman coke pushers

...engineered for economical, trouble-free performance

Wellman Combined Coke Pusher, Coal Leveler and Door Extractor in operation at Bethlehem Steel's Lackawanna Plant.

● Many of the world's most modern byproduct coke oven plants are Wellman equipped. The Wellman Engineering Company's more than half-century experience in building heavy machinery guarantees sound design and expert construction. Wellman equipment provides peak economy, maximum safety and trouble-free performance under a wide variety of operating conditions.

THE WELLMAN ENGINEERING COMPANY

7000 CENTRAL AVENUE • CLEVELAND 4, OHIO

Air pressure reaching tool can be checked with a hypodermic needle-gage device.

vigilance over their air systems. Conversely, where reasonable maintenance is not conducted, a loss in production and dollars is experienced.

One of the greatest production robbers is low pressure.

It has been found that if the pressure at a pneumatic tool falls from 90 psig to 70 psig, production output of that tool may drop as much as 35 per cent. Somewhat more specific is the case of the air motors which are used extensively to power air tools and devices. Air motors offer more horsepower per unit weight than other comparable power sources. Because compressed air systems in most plants utilize pressures between 90 and 110 psig, air motors are designed to operate within those working pressures. An air motor, built to operate at 90 psig, however, will lose 25 per cent of its capacity if line losses in delivering air drop the pressure to 70 psig.

First inclination when air pressures drop may be to place the blame on insufficient compressor capacity. A check of the air distribution system, first, may save the cost of new compressor equipment.

One of the principal causes of low-air pressure are leaks in the distribution system.

Checking the air distribution system for leaks is a relatively simple matter. Results have proved that the most likely location of small leaks are around valve stems, hose connections, unions, drains, home-made blow guns, and lines leading to inoperative tools. Of course, the entire system should be checked with particular attention to the above and to lines which are subjected to unusually rugged treatment.

Inspections should be made monthly.

Plant maintenance departments have come up with many simple and rather unique ways to check leaks. Most frequently used are the lighted candle or the solution of soapy water which is brushed around suspected areas. One manufacturer puts essence of peppermint into the air system. Detection of the slightest leak is by odor. Still another method, rather ingenious, is the use of what heretofore may have been considered nothing more than a youngsters' toy. A small siren-like whistle, activated by air flow, is passed over the lines, a siren noise indicating a leak. Regardless of what method is adopted, when leaks are found, patch them immediately.

TABLE I — COST OF AIR LINE LEAKS

Size of opening (In.)	Air lost (Cu ft per month at 100 psig based on nozzle coefficient of 0.65)	Cost of air lost ($0.07 per 1000 cu ft)
3/8	6,671,890	467.03
1/4	2,920,840	204.46
1/8	740,210	51.81
1/16	182,272	12.75
1/32	45,508	3.19

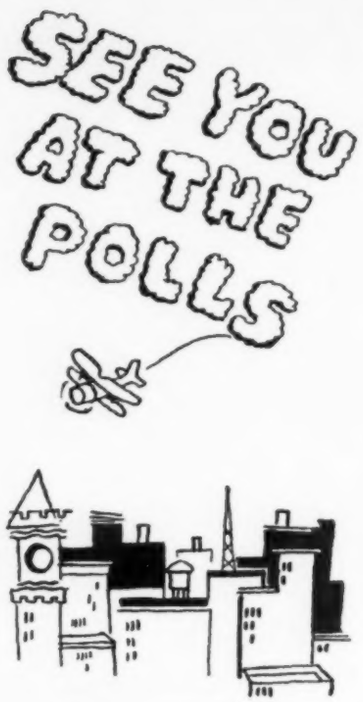
Some of the leaks may be very small, appearing trivial in themselves. But such leaks may be numerous and have a high accumulative effect. Actually these leaks spell a very definite dollar loss as shown in the table.

This dollar and cents wastage more than justifies scheduled maintenance of air distribution systems.

Couple this dollar savings to the increased productive output of the pneumatic tools and it is easy to see that it pays to keep the air lines tight.

POLE-TOP HANGER

▲ Safe, efficient ground-level maintenance now is possible for lights mounted on new standard metal poles of any height. This time-saving operation is accomplished by means of a newly developed pole-top unit incorporating the patented Thompson Electric Co. disconnecting and lowering hanger mechanism. Since the maintenance man works at ground level with a "dead" fixture

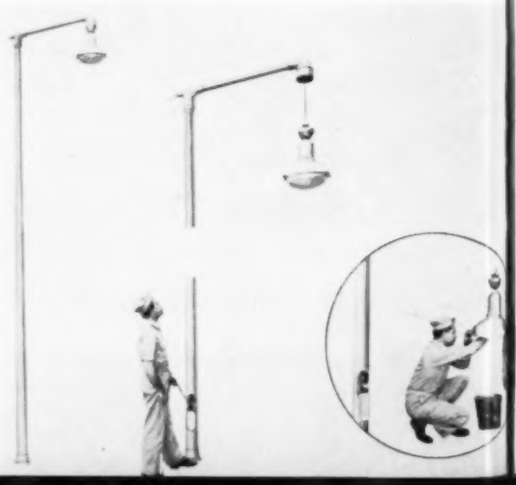


(the live contacts stay at pole top), there are no climbing or electrical hazards. In addition, the fixtures can be serviced with greater frequency and minimum cost.

Of equal importance is the fact that greater luminaire mounting heights are feasible now because maintenance no longer is a problem. Long recognized as desirable, greater mounting heights have been restricted to date by the lack of practical means for servicing the fixtures. Also, the need for costly service equipment has been eliminated by the new Thompson pole-top hanger assembly.

This new unit includes a pole-top fitting complete with self-contained pulley, a divided mast-arm, the stainless steel operating cable, and a mast-

Ground-level maintenance that enables repairmen to work with a "dead" fixture is made possible by a new pole-top unit.



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EQUIPMENT NEWS

(*Continued from page 290*)

arm end fitting. The mast-arm, a high-strength aluminum alloy extrusion contains a Y-shaped partition for both increased stability and separation of the movable operating cable from the electrical wiring. Diameter and wall thickness of this arm are comparable to 2-in. extra-heavy pipe.

The mast-arm end fitting, incorporating Thompson hanger mechanism, features a self-contained "plumbizer" that provides for 8 degrees adjustment either side of the centerline. This assures accurate vertical suspension of the luminaire, which is essential for operation of the hanger assembly.

Book Reviews . . .

▲ **"Was Der Siemens-Martin Stahlwerker Von Seiner Arbeit Wissen Muss,"** by K. Mayer. (What the open-hearth crew must know about their work), 152 pages, 8¼ in. by 5¾ in., 233 illustrations, was published in 1952 by "Stahleisen," Dusseldorf, Germany, price 8.50 German Marks. This book is an excellent guide for men who work in an open-hearth shop. It treats of everything in the open-hearth shop, from the materials that enter the furnace to the care of regenerators. It deals with refractories, with all furnace details, with gas producers and with all other auxiliary equipment such as, for instance, ladles and their stoppers, ingot molds, machines for grinding molds, and much other related equipment. The instructions for operating and maintaining each piece of equipment are very complete. They start with sorting the scrap and end with the teeming operation. Rules for safety are included in the practical hints. Elementary physics and chemistry of the process are discussed, without, however, mentioning these two words. The great majority of open-hearth furnaces in Germany are fired with producer gas. In some plants, blast furnace gas and coke oven gas are added to producer gas. In a few works coke oven gas alone is burnt. For that reason, equipment for burning oil or tar is not described. In consequence, some sections of the book cannot be applied to American conditions. The book is in German and was reviewed by W. Trinks.

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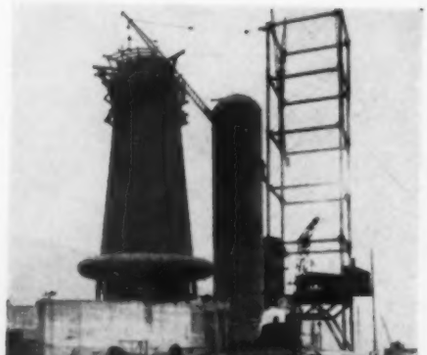

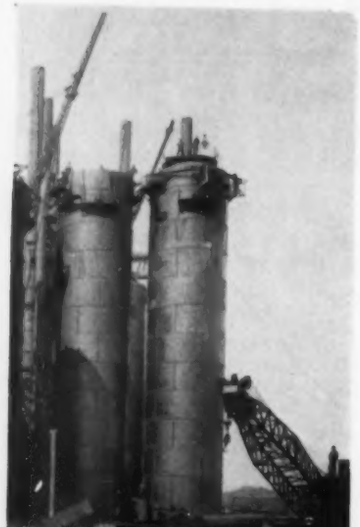

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Farval never overlooks a bearing in lubrication of Swinging Coiler

THE rough and tumble treatment which thick-gauge metal alloys impose on coilers calls for a truly modern centralized lubricating system—calls for never-miss Farval.

As every bearing on the Torrington 4-housing Swinging Coiler (at right) plays a vital and exacting role in the looping of tough metal coils, each one needs individual and proper lubrication. Hit and miss, half-blind hand oiling invites bearing trouble and expense as well as costly down time. So this 65-year-old Connecticut company protects the machines it builds with Farval Centralized Lubrication. Its engineers say, "Farval overlooks no bearings, saves lubricating time and proves a valuable sales feature appealing to our customers."

In steel mills, metal working plants and manufacturing establishments of all kinds, both at home and abroad, Farval Centralized Lubrication is protecting millions of industrial bearings.

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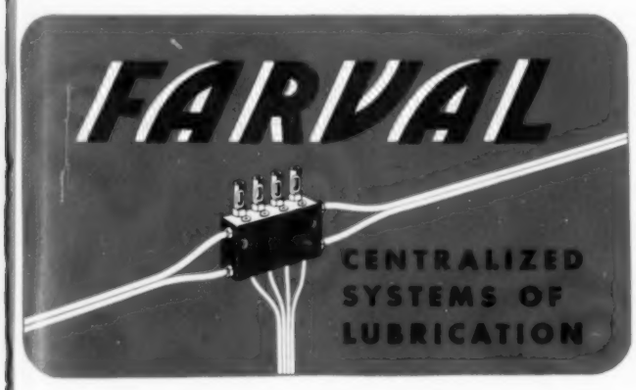
For a full description, write for Bulletin 25. The Farval Corporation, 3278 E. 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers, Ltd.



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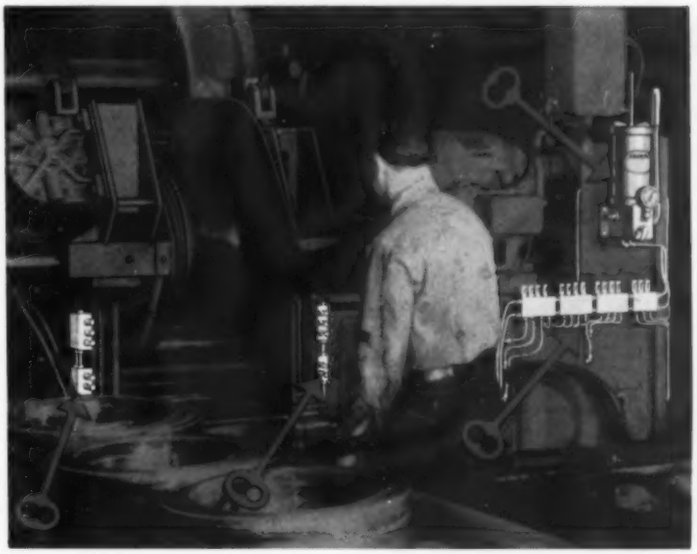
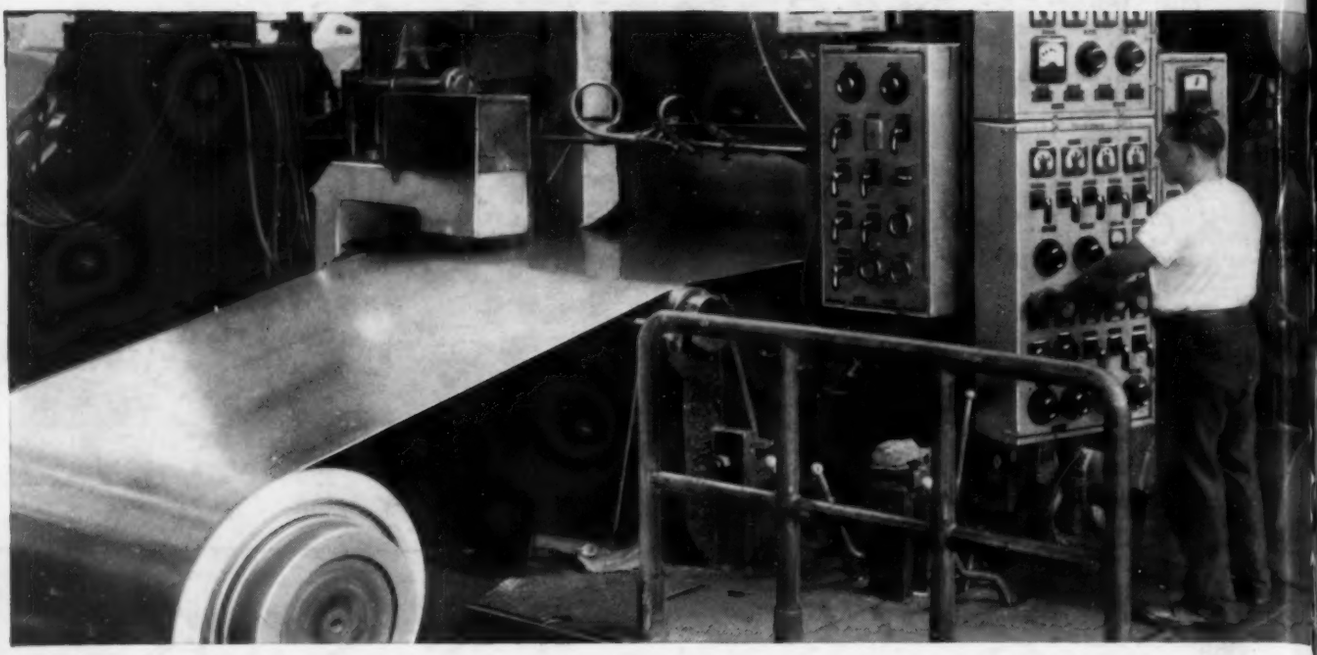
No. 136



KEYS TO ADEQUATE LUBRICATION—*Wherever you see the sign of Farval—the familiar valve manifolds, dual lubricant lines and central pumping station—you know a machine is being properly lubricated. Farval manually operated and automatic systems protect millions of industrial bearings.*

Illustration of 4-Housing Swinging Coiler by courtesy of The Torrington Manufacturing Company



CONTINUOUS GAGING is provided by the non-contacting, 50-kv G-E X-Ray Thickness Gage installed on this 4-stand tandem sheet mill. Gage operates between last stand and an idler roller preceding winding reel.

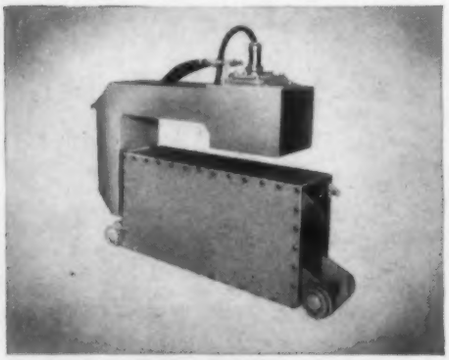
G-E X-Ray Thickness Gage cuts scrap losses, saves steel

Continuous, non-contacting gaging enables hot and cold mill operators to get on gage faster, roll to closer tolerances

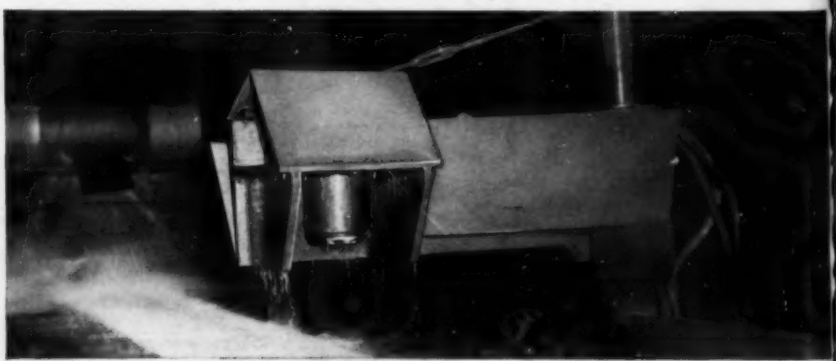
Now—with the General Electric X-Ray Gage—hot mill users can reach gage on the first slab, reduce re-rolls; cold mill users can get on gage faster, roll to closer tolerances.

Pioneered by General Electric, it is now used by most steel companies because it is accurate, dependable, and withstands severe rolling-mill conditions. In 50- and 100-kv ratings, it covers a range from as low as .005 inch for cold mills to as high as .400 inch for hot mills.

For more data, contact your G-E steel mill specialist or write for Bulletin GEA-5622 to General Electric Co., Section 687-100, Schenectady 5, N. Y.



FOR COLD MILLS, this 50-kv gage is mounted as one unit. Top arm contains detector located eight inches above bottom tank which contains x-ray tube and transformer.



FOR HOT MILLS gages like this 100-kv gage at Weirton Steel Company, Weirton, W. Va., measure the thickness of hot-strip steel at speeds exceeding 1700 fpm. Weirton operators say it enables them to reach gage on the first slab. Formerly four slabs could go through the mill before a report on gage was obtained.

GENERAL ELECTRIC